STUDIES ON THE TREMATODES OF CERTAIN ECONOMICALLY IMPORTANT FISHES OF CHAMBAL REGION

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It is further certified that the candidate has put in an attendance of over 200 days in this department from the date of his registration for the Ph.D. Degree of the Bundelkhand University as required under relevant ordinances.

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PART I GENERAL

Due to compelling economic reasons the fish farming is developing fast into a major profitable industry. In India over 7.5 million people depend on fish and fishery for their livelihood, while 23,000 are engaged in ancillary vocations such as basket and ice-making, fish processing and transport etc. (Pandey, 1977). The importance of fish as an efficient food converter, as compared to other conventional terrestrial farm livestock has been stressed by Jolly (1978) who has reported that some species of fishes take less than 2 gm. of food to add 1 gm. to their own body weight. The fish fauna constituting one of the most important economic groups, responsible for providing much needed animal protein to the hungary millions, is also rich source of many medicinal and industrial oils, fish meals, insulin, minerals, vitamin A and B, and B—complex and many protolytic Besides these, numerous industrial products are manufactured from different organs of fish. Imitation pearls, foam producing extinguishers and active carbon are made from the fish scales. Isinglaso and many other adhesives are made from the swim bladders. Leather, gelatin, glue, histamine, guanine and cystine are also derived from the fish waste.

The fresh water fishes contain 54-82% moisture and oils, 13.5 - 25.2% proteins, 1 - 2% minerals and about 1% other constituents. The fish protein occupies an important place in nutrition as it has high digestibility and biological and growth promoting value. Such proteins are balanced well with respect to essential amino acids and are comparable with other proteins of animal origin. The protein of certain fish species is reasonably rich in lysin and mothiomine contents. Studies in the growth of rats have proved that fish proteins are somewhat superior to egg albumen, beef protein and casein and are of the same class as Chicken (Anon, 1962). The mineral constituents of fish muscles include almost all essential elements like calcium, magnesium, potassium, phosphorus, sulphur, copper, manganese, strontium, zinc, vanadium bismith, silver, cobalt, mercury, aluminium, barium, lead, molybdeum, nickel, titanium, chromium, nibium, boron, lithium, antimony, silicon, bromino, fluorine and iodine. Cadmium and gold have also been reported from some species.

The environment of fish covers more than 70% of this planet. Realising the great economic potential in regard to a good source of animal protein and other benefits of fish production, Government of India and other State Governments have launched many schemes for the brisk development of this industry.

Proposals for adopting composite culture technology to provide adequate protein food to rural masses and additional job opportunities to the poor fisherman communities are also being considered. According to recent estimates (Anon, 1979) a seven—fold increase in fish production is possible through this technology. There are enormous fresh—water sources in the form of vast river systems, their tributaries, streams, lakes, reservoirs, tanks, ponds and paddy fields for indigenous fisheries in India. It has been estimated that the total length of principal rivers and their tributaries is C 27, 360 km. and nearly C 1,12, 650 km. area is under the canals and other such irrigation channels. Besides this, the total area of fresh water ponds and tanks of our country is about 1.6 million hectares.

For a successful exploitation of the vast fish resources a properly managed and scientifically based fisheries development programme is essential. Fish—like other animals are prone to a number of diseases which are responsible for heavy losses due to mortality and morbidity. Therefore, a proper understanding of the fish diseases is a prequisite for achieving healthy fish farming to ensure high yields. Among the various parasitic diseases of fish, helminths form a major group. Among all the known helminthic parasites of fishes in India, according to Chauhan (1963), trematode parasites constitute the largest group which has

attracted the greatest attention of scientists. The significance of terematode parasites among the fishes can very well be understood through the work of Klass (1963) who after an ecological survey of metacercariae of a single trematode parasite warned that future fisheries Clinostomum marginatum management of U.S.A. will be adversely hit if this parasite is not controlled. In view of high prevalence and intensity of trematode parasites among Indian fresh—water fishes Malberg (1975) has warned against introduction or import of Indian fishes in U.S.A. Besides, substantially cutting the economic gains from the fishes by impairing their health, the trematode parasites are responsible for many zoonotic diseases of man and animals through the fish which act as a transport or intermediate host. These parasites exert harmful effects on the health in a variety of ways. Cross (1933) showed that prarasitic infestation tends to decrease the growth rate resulting in stunting of fish. Kawai (1937) reported that Clonorhis sinensis causes jaundice, decrease in blood sugar and pathological changes in liver of experimentally infected animals. In experimental infection Hunter and Hunter (1938) found that in small mouthed blackbass fingerlings strigeid matacercaria caused a significant loss of weight resulting in emaciation of fishes. Volf (1953) has listed many gill and eye diseases of fresh-water fishes caused by trematode parasites. Parasitic castration has been reported by Izyumova (1964) and Korr (1948). The yield of fish products like liver oil is affected due to the damage to liver tissue during heavy infestation. After survey of Indian fish—parasites Tripathi (1959) opined that helminthic infections, when heavy, could constitute a major factor in morbidity and even mortality of fishes. Parasitic infection recorded by him was 64.95% in pond fishes. In a brief survey of helminth parasites of Uttar Pradesh Rai (1966) found that 21 species of fresh water fishes were infected with 10 adult and 11 larval trematode parasites which damage different vital organs like liver, alimentary canal and urinary bladder. Srivastava et.al. (1975) found the helminthic infections, in three reservoirs of U.P., was 20 — 60%.

Fish born zoonosis is more significant, specially in case of trematode parasites, which involves many hosts for completion of their complex life cycles. Witenberg (1932) has listed 14 species of trematodes transmitted to man through eating uncooked fish in Palestine. Mauror (1969) and Nealy (1970) have also reported many species of fishes that act as carriers in human trematode infections. Lamcy et. al. (1976) have reported a case of a French Professor who acquired infection of Metagonimus yokogawai by frequently eating raw fish during his visit to Japan.

Trematode parasites cause numerous diseases in fishes and other economically important animals. The common mode of transmission of infection is the transport of metacercarial/ cercarial forms that usually become encysted in the liver, subcutaneous muscles and mesentery of intestine and other vital organs or underneath the scales, fins, operculum and nictitating membrane or gill-membrane of fishes. Such fish with encysted stages, when eaten by a definitive host infection sets in and further development of the parasite is ensured. Wright (1947) incriminated 49 species of trematodes responsible for fish-born zoonosis. Similar information from our country is scanty as only a few workers have explored this aspect. Noteworthy contributions are those of Bhalerao (1932), Gupta and Pande (1963), Rai and Pande (1965), Rai (1966 b, 1969 and 1976), Ansari (1968), Sastry and Patnaik (1968), Sahai (1969), Prasad and Mohan (1970) Sahai and Srivastava (1971) Pande and Shukla (1974), Madhavi (1978) etc.

Since then numerous publications, on both monogenetic and digenetic trematodes of fresh water fishes of India, have contributed dealing mainly with the taxonomy and morpholigical studies. The systematic and taxonomic position of many Indian forms is also not satisfactory as a number of genera and species have been raised on insufficient material without any consideration

of wide range of morphological variations which is a common feature in this group. Recent studies of Vinod Agrawal, P. Rai, S.P. Gupta, D.N. Fotedar, K.C. Pandey and their co—workers etc. have amply proved this point. Several of these forms need re—examination through sufficient material and observations on the biology. Besides this, the parasitism is reported to have brought about behavioural influence in fishes in some cases.

Srivastava (1975) opined that the number of intermediate hosts involved is one of the important biological factors, among others, for the determination of fish parasitism in any confined body of water.

The trematode parasites of Chambal region have not been studied properly so far. Therefore, this area requires more attention of helminthologists because a majority of people of this region containing areas of Madhya Pradesh, Rajasthan and Uttar Pradesh use the fresh water fishes as their food.

With the above background in mind, the present study was undertaken. The observations embodied in the Thesis are based on the material gathered from extensive survey of digenetic trematodes from Chambal river passing through the Chambal region and various small and large water bodies which are filled mainly with the rain water. All these water bodies are rich in

fish fauna and provide better fisheries and aquaculture prospects.

Chambal region is considered to be a very prominent area of the country as it is full of ravines and which provide safe shelter to decoites. Several famous films have also been made on the dacoites of this region.

The Chambal region is comprised of areas of three states i.e. Rajasthan, Madhya Pradesh and Uttar Pradesh. The Chambal river separates the Rajasthan and U.P. from Madhya Pradesh. This region is comprised of 4 districts, namely Dholpur of Rajasthan, Morena and Bhind of Madhya Pradesh, and Etawah of U.P. On the North west of Chambal river is Rajasthan, on North—east is U.P. and on the South of it is Madhya Pradesh.

The Chambal river is the only major river of this region which extends from one end of Chambal region to other. The river is very vast in which water remains throughout the year. It is also a fact that numerous small and large water bodies in the region beside the Chambal river, are a good source of inland fisheries. All popular groups of fishes such as major carps, cat fishes, live fishes, feather backs, sheet fishes, eels etc. form the bulk of total production of this region.

Thus, efforts have been made to concentrate the work on these host fishes and to obtain maximum number of parasites from them throughout the period of study. The attempt has been made to fill a part of the wide lacuna left on the studies of digenetic trematodes of fishes of Chambal river and other water bodies of Chambal region.

The thesis incorporates the detailed taxomorphological description of 19 species of trematodes including 11 new forms, belonging to Order Digenia. Beside it, five digenetic larval forms also have been described including three new forms. The validity of certain species has been discussed.

Among digenetic treamtodes ninteen species, belonging to 11 genera and 8 families, have been described in detail. The new species described in this thesis are eleven. Beside it the validity of the genus *Haplorchoides* Chen, 1949 and *Haplorchis* Looss, 1899 has been discussed in detail under the heading "On the validity of Haplorchinae flukes from Indian Siluroid fishes". *Genarchopis goppo* (Tubangui) Ozaki, 1925 is redescribed. The variations met within the worms and validity of various species have been discussed. An attempt has been made to re—study various species of the genus for their validity.

Under the Third Part five larval digenetic trematodes have been described including three new forms viz. Bucephalus chauhani, Diplostomulum majumdari and Prohemistomulum jaini.

The detailed study of *Bucephalus chauhani* n.sp. has been made. Its morphology, taxonomy and experimental development in one fish and a laboratory mammal has been given. Certain taxonomic changes and amendments in the diagnosis of certain families and genera have been suggested. In a few species key for the identification of species is also added.

In the last a complete BIBLIOGRAPHY and a SUMMARY of the thesis are also given.

6.6

Helminth parasites have been known to mankind since Vedic and post — Vedic periods around 800 B.C., as in *Atharvaveda* these worms are referred to as Krimis. Great medical treatises of Charak and Susruta (between 200 B.C. and 200 A.D.) even mentioned detailed treatment of parasites. A detailed account of knowledge of these worms in ancient India is given by Bhaduri, Tiwari and Biswas (1972).

Our present day knowledge of helminth parasites dates back to 1379, when Jehan—de—Brie (1379) who for the first time discovered fluke *Fasciola*. The first reference to trematodes, probably *Fasciola jacksoni* and *Pseudodiscus hawkesi*, from Indian region in modern times is made by Gilchrist, who has worked on them in the years 1841 — 1846. Later on, cobbold (1869 — 1882) wrote a series of papers describing parasites of elephant, cattle and Gangetic dolphin and thus making the begining of the scientific study of trematode fauna of India.

Bhalerao (1926) was the first Indian helminthologist to give a boost to Indian helminthology in general and study of trematodes in particular. He was followed by a band of dedicated workers like Mehra, Verma, Moghe, Thapar, Lal, Srivastava (H.D.), Chauhan (B.S.), Pande (B.P.) and many others, who contributed

much to our present day knowledge of the trematodes from Indian region. Bhalerao (1939) reviewed the progress of the knowledge of trematodes in India till that time. In Thapar (1956) and Chauhan (1963) also discussed the progress of helminthology in India with special reference to trematodes. Some of the more important contributions in this field include.

Bhalerao (1926, 36); Verma (1927, 36); Chauhan, B.S. (1940, 49, 54, 55); Srivastava, H.D. (1938, 48); Mehra H.R. (1935, 38, 62,66); Pande, B.P. (1937); Patwardhan (1935); Khan (1935); Mehra, R.K. (1941); Kaw (1950); Dayal (1948, 49,50); Baugh (1949, 50); Gupta (1950, 51, 55, 56); Jaiswal (1957), Jain (1967) and Pandey, K.C. (1970).

Helminth parasites of Indian fishes have not received the attention they deserve, except for the systematics of certain parasites. A perusal of literature shows that following Indian workers have described the trematode parasites of Fishes —

Billet (1899) described *Isoparaorchis hypselobagri* from *Wallago attu* and also immature forms of the some from *Barbus* tor, Channa striatus, Notopterus notopterus and mastacembelus armatus from India.

Southwell (1913) described *Isoparorchis trisimilitubis*, which was later renamed as *I. hypselobagri* from the air bladder of

Wallago attu. Verma (1927) reported Opisthorchis pedicellata from the gall bladder of Rita rita. He (1935) also recorded gastorostomes from siluroid fishes.

A large number of workers have made substantial contribution on the *taxonomy* of trematode poarasites. These include:—

Southwell and Prashad (1918) described *Clinostomum* piscidium from *Nandus nandus*.

Verma (1927) described *Opisthorchis pedicellata* from *Bagarius vattellii* and *Rita rita* from Allahabad.

Thapar (1930) described Gomtia piscicola from *Bagarius* vattellii from Lucnow.

Srivastava, H.D. (1933) described *Progonus piscicola* and *Progonus ovocaudata* from *Ophiocephalus punctatus; Ophiocorchis lobata* and *Ophiocorchis singularis* from *Ophiocephalus striatus* from Allahabad.

Pande (1934) described *Orientocreadium indicum* from *Heteropneustes fossilis* and *Rita buchanani* from Allahabad. In (1937) he described *Allocreadium handiai* from *Ophiocephalus punctatus*. In (1938) he described *Allocreadium kosia from* Barbus *chilinoides; Allocreadium schizothoracis* from *Schizothorax micropogon; Allocreadium mahaseri* from *Barbus tor* from Allahabad.

Dayal (1949) described *Phyllodistomum vachius* from *Eutropiichthys vacha* from Lucknow and Allahabad.

Bhalerao (1941) described *Clinostomum indicum* from *Notopterus notopterus* from Allahabad. In 1942 he described *Clinostomum dasi* from *Saccobranchus fossilis* and *Clinostomum prashadi* from an unidentified fish from Hyderabad.

Mehra (1941) described *Opisthorchis pedicellata minutus* from *Mystus seenghala* and *Wallago attu* from Allahabad.

Gupta (1950) described Allocreadium thapari from Rita rita from Hardoi. In (1951) he described Phyllodistomum singhiai from Mastacembelus armatus from Lucknow and Sharanpur. In (1953) he described Haplorchoides seenghali from Macrones seenghala; Phyllodistomum vittatusi from Macrones vittatus; Haplorchoides ritai, Haplorchoides brahamputraensis from Rita rita from Assam; Haplorchoides gomtioensis from Silundia ganetica from Lucknow. In 1956 he described Allocreadium kamali from Chela bacaila, Allocreadium mehrai from Rhychobdella aculeata from Lucknow. In (1963) he described Allocreadium makundai from Barbus sarana from Banaras.

Gupta and verma (1976 publ. 1977) described *Allocreadium* mrigali, *Allocreadium baranai*, *Allocreadium saranai* from *Cirrhina* mrigala, *Barilius barana* and *Barbus sarana* respectively.

Kaw (1950) described *Allocreadium nemacheilus* from *Namacheilus kashmirensis; Clinostomum schizothoroxi* from *Oreinus sinuatus, Schizothorax micropogon; Phyllodistomum loossi* from *Schizothorax socinus* from Kashmir.

Jaiswal (1957) described *Phyllodistomum (Catroptoides)* indianum from *Heteropneustes fossilis* and *Phyllodistomum* parorchium from *Glossogobius (Gobius) giuris; Euclinostomum* chanai from *Ophiocephalus punctatus; Clinostomum macrosomium* from *Mastacembelus armatus* from Hyderabad.

Saksena (1958) described *Orientocreadium raipurensis, Orientocreadium dayali* from *Clarias batrachus; Allocreadium spindala* from *Mastacembelus armatus* from Raipur. In 1960 he described *Orientocreadium umadasi* from *Clarias batrachus* from Raipur.

Srivastava, P.S. (1960) described *Allocreadium ophiocephali* from *Ophiocephalus punctatus* from Raipur.

Motwani and Srivastava (1961) described *Phyllodistomum* chauhani from *Mystus tor* and *Mystus seenghala; Phyllodistomum* tripathi from *Bagarius bagarius* from India.

Rai (1962) described *Allocreadium dollfusi, Allocreadium* singhi, *Allocreadium hirnai* from *Barbus tor* from the river Hiran, near Katangi and Sehora (M.P.).

Srivastava, C.B. (1961) described *Pycnadena komiyai* from *Oxygaster gora* from India.

Agarwal (1964) described Allocreadium heteropneustusius from Heteropneustes fossilis; Haplorchoides macroni from Macrones seenghala from Lucknow. In 1966 she described Genarchopsis punctati from Ophicephalus punctatus from Lucknow.

Kakaji (1969)' described *Genarchopsis cameroni* from *Mystus seenghala; Allocreadium catlai* from *Catla catla; Genarchopsis cuchiai* from *Amphipnous cuchia* from Lucknow. In the same year, she described *Allocreadium guptai* and *Allocreadium fasciatusi* from *Rita rita* and *Trichogaster fasciatus* respectively, from Varanasi.

Fotedar (1969) described *Phyllodistomum megacotyle* from *Garra mullya* from Kashmir.

Pande, B.P. and Shukla, R.P. (1976) described *Haplorchoides* pearsoni and *Haplorchoides mehrai* from *Channa punctatus* and *Mystus vittatus* respectively from Lucknow.

Gupta, V. and Puri, M. (1979 publ. 1980) described Allocreadium calbassii, Allocreadium manteri from Labeo calbasu, Anabas testudineus respectively from Lucknow. In Madhya Pradesh also, lot of work was done at Jabalpur, Raipur, Rewa, Ujjain and Gwalior by Singh, Agarwal, Dwivedi, Rai, Saxena, Jain, Khoche, Johri, Dandotia and others. However, almost no work has been done on the helminth parasites of fishes of Chambal region.

From the foregoing account, it is evident that considerable progress is being made in the knowledge of helminth fauna and its taxonomic study in this country, but very little work has been done to ascertain the incidence of parasites and estimation of helminthic infection.

The important contributions in this field have been by Srivastava, C.B. and Mukherjee, G.D. 1986; Siddiqui, A.H. and Nizami, W.A. (1988), Devraj, M & Ranganathan, V. (1991); Bhadauria, S. 1992; Bhadauria, S. & Dandotia, M.R. (1984, 1992, 1994) and others. Still a wide lacuna is left in this field considering the richeness of fauna of helminth parasites.

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4.4

The host fishes were collected mainly from one river, namely Chambal, passing through the Chambal region. The prominent collections were made in the districts of Morena, Bhind and Dholpur. Beside these, certain small dams made on Chambal river were also examined for the collection of host fishes. The fishes were also purchased from the local fish markets of Morena and Bhind, and from certain fish sellers at Dholpur. These fishes were a part of catch from the rivers Chambal and certain ponds of the region.

The host fishes were kept alive in aquaris in the laboratory and then freshly killed, dissected and examined at convenience. A thorough search was done to determine the where—abouts of parasites. Various organs particularly body cavity, stomach, duodenum, intestine, rectum, gall bladder and kidneys were carefully examined in petridish under low power binocular.

Soon after collection or recovery, the trematodes were throughly washed and kept in sline water. They were studied alive and observations were made regarding the colour and movements of body, spines on the body, oral and ventral suckers, cirrus and metraterm, excretory bladder and its branches.

For fixation of trematodes 5 - 10% formaline was used. For whole mounts, preservation in formalin for longer periods gave good results. For preparing whole mounts, precaution was taken to avoid over or under pressure.

For preparing whole mounts of trematodes, after fixation and thorough washing in water, worms were dehydrated and stained in Borax carmine, then cleared in xylene and finally mounted in DPX. The drawings of the whole mounts were made with the help of a camera lucida at a suitable magnification.

The fishes were examined at regular intervals from July 1993 to June 1996. A total of 1865 fishes belonging to different species available from Chambal river and other water bodies were collected and examined, and the trematodes procured from them were studied alive and after preparing whole stained mounts. All measurements are given in millimeters (mm.), if and otherwise not mentioned at any place.

Only the species of trematodes which were either new to science or of any morphologic or taxonomic importance have been included in the thesis.

A SYSTEMATIC LIST OF HOSTS EXAMINED

Below is given a systematic and composit list of fresh—water fishes found and examined in Chambal river and other water bodies in the Chambal region. It contains 58 species belonging to 36 genera and 16 families of the fishes.

Order: CLUPEIFORMES

Family: CLUPEIDAE

- 1. Gudusia chapra (Hamilton)
- 2. Goniolosa manimina (Hamilton)
- 3. Corica saborna (Hamilton)
- 4. *Ilisha motius* (Hamilton)

Family: NOTOPTERIDAE

- 5. *Notopterus chitala* (Hamilton)
- 6. *Notopterus notopterus* (Pallas)

Order: CYPRINIFORMES

Family: CYPRINIDAE

- 7. Oxygaster bacaila (Hamilton)
- 8. Barilius barila (Hamilton)
- 9. Barilius barna (Hamilton)
- 10. Barilius bendelisis (Hamilton)
- 11. Barilius bola (Hamilton)
- 12. Danio (Brachydanio) rerio (Hamilton)

- 13. Rasbora daniconius (Hamilton)
- 14. Aspidoparia morar (Hamilton)
- 15. Amblypharyngodon mola (Hamilton)
- 16. Puntius chaqunio (Hamilton)
- 17. Puntius sarana (Hamilton)
- 18. Puntius sophore (Cuvier & Valenciennes)
- 19. Puntius ticto ticto (Hamilton)
- 20. Tor tor tor (Hamilton)
- 21. Labeo calbasu (Hamilton)
- 22. Labeo fimbriatus (Hamilton)
- 23. Labeo gonius (Hamilton)
- 24. Labeo rohita (Hamilton)
- 25. Cirrhinus mrigala (Hamilton)
- 26. Cirrhinus reba (Hamilton)
- 27. Catla catla (Hamilton)
- 28. Osteobrama cotio (Hamilton)
- 29. Crossocheilus latius latius (Hamilton)

Family: COBITIDAE

- 30. Noemacheilus botia (Hamilton)
- 31. Noemacheilus rupicola inglisi Hora

Family: BAGRIDAE

- 32. *Mystus (Aorichthys) aor* (Hamilton)
- 33. Mystus (Aorichthys) seenghala (Sykes)

- 34. Mystus (Mystus) bleekeri (Day)
- 35. Mystus (Mystus) cavasius (Hamilton)
- 36. Mystus (Mystus) vittatus (Bloch)
- 37. Rita rita (Hamilton)

Family: SCHILBEIDAE

- 38. Ailia coila (Hamilton)
- 39. Clupisoma garua (Hamilton)
- 40. Eutropiichthys murius (Hamilton)
- 41. Eutropiichthys vacha (Hamilton)
- 42. Silonia silondia (Hamilton)

Family: SILURIDAE

43. Wallago attu (Bloch)

Family: SISORIDAE.

- 44. Glyptothorax telchitta (Hamilton)
- 45. Pseudeutropius atherenoides (Bloch)
- 46. Pseudeutropius gurua (Hamilton)

Order: PERCIFORMES

Family: CENTROPOMIDAE

47. Ambassis nama (Hamilton)

Family: NANDIDAE

48. Nandus nandus (Hamilton)

49. Badis badis (Hamilton)

Family: SCIAENIDAE

50. Pama pama (Hamilton)

Family: GOBIIDAE

51. Glossogobius giuris gluris (Hamilton)

Order: OPHICEPHALIFORMES

Family: CHANNIDAE

52. Channa marulius (Hamilton)

53. Channa punctatus (Bloch)

Order: BELONIFORMES

Family: BELONIDAE

54. Xenentodon cancila (Hamilton)

Order: MASTOCEMBELIFORMES

Family: MASTOCEMBELIDAE

55. *Macrognathus aculeatus* (Bloch)

56. *Mastocembelus armatus* (Lacepede)

57. Mastocembelus pancalus (Hamilton)

Order: TETRAODONTIFORMES

Family: TETRAODONTIDAE

58. *Tetraodon cuteutia* (Hamilton)

HOST — PARASITE LIST

Selected fresh water fishes collected from Chambal river and other water bodies in the Chambal region have been examined for the taxomorphological studies of digenetic trematodes. Most of the fish species were available in plenty. These live fishes were examined thoroughly for digenetic trematode infection. The parasites were collected from various body parts.

The following host—parasite list includes only those fishes which were found harbouring the parasites included in this thesis. Majority of the parasites form first host and locality record from Chambal region. Moreover, certain species of trematode parasites have been recovered from their hosts for the first time, not reported in the literature so far.

Host — Parasite List

(A) Adult Trematodes

Name of the Host	Name of the parasite recovered		
Gudsia chapra (Hamilton)	Phyllodistomum chandrai n.sp.		
Corica soborna (Hamilton)	Bucephalus kailarasi n.sp.		
Barilius barila (Hamilton)	Phylodistomum tripathi Motwani & Srivastava, 1961		
Barilius bola (Hamilton)	Gorgotrema barbius Dayal, 1938		
Eutropiichthys vacha (Hamilton)	Haplorchis piscicola		
Puntius sarana (Hamilton)	Asymphylodora chambali n.sp.		
Mystus seenghala (Sykes)	Haplorchis attenuatus		
Mystus vittatus (Bloch)	Haplorchis piscicola		
Rita rita (Hamilton)	Neopodocotyle morenai n.sp.		
	<i>Phylodistomum agarwali</i> n.sp.		
Clupisoma garua (Hamilton)	Neobucephalopsis dholpurensis n.sp.		
	Haplorchis piscicola		
Wallago attu (Bloch)	Haplorchis attenuatus		
Gyptothorax telchitta (Hamilton)	Astiotrema reniferum (Looss, 1898) Stossich, 1904		
Ambasis nama (Hamilton)	Neopodocotyle dholpuri n.sp.		
Channa punctatus (Bloch)	Genarchopsis dwivedii n.sp.		
v	Genorchopsis goppo		
	Genorchopsis piscicola		
	Allocreadium handiai		

Xenontodon cancila (Hamilton)

Bucephalopsis nekpuri n.sp.

Pseudentropius gaura (Hamilton)

Bucephalopsis gaurai

Macrognathus aculeatus (Bloch)

Caballeroia milionai n.sp.

Clarias batrachus (Linn.)

Allocreadium handiai

Heteropneustes fissilis (Bl.)

Allocreadium handiai

Haplorchoides seenghali

Channa striatus (Bl.)

Genarchopsis singularis

(B) Larval Trematodes

Channa punctatus (Bl.)

Metacercaria of Euclinostomum

heterostomum

Mystus vittatus (Bloch)

Metacercaria of Isoparorchis

hypselobagri

Eutropiichthys vacha (Hamilton)

Bucephalus chauhani n.sp.

Bagarius bagarius

Bucephalus chauhani n.sp.

Silonia silondia (Hamilton)

Diplostomulum majumdari n.sp.

Badis badis (Hamilton)

Prohemistomulum jaini n.sp.

4.4

PART II

TAXONOMY AND MOIRPHOLOGY OF CERTAIN DIGENETIC TREMATODES

Family: ALLOCREADIIDAE Stossich, 1903

Sub Family: ALLOCREADIINAE Looss, 1902

Genus: Allocreadium Looss, 1900

Allocreadium handiai Pande, 1937 (Plate I, Fig. 1)

Twenty eight specimens of this species were collected from the intestine of *Clarias batrachus* (Linn.); *Heteropneustes fossilis* (Bl.); *Channa punctatus* (Bl.) and *Channa striatus* (Bl.) procured from a pond in District Morena (M.P.)

DESCRIPTION

Body small to large, aspinose, elongated with rounded anterior and posterior extremities, measures $0.75-2.8 \times 0.28$ — 0.53. Oral sucker subterminal, spherical, measures $0.15-0.24 \times 0.13-0.24$. Prepharynx absent. Pharynx oval, muscular, $0.05-0.09 \times 0.05-0.09$ in size. Oesophagus moderately long, 0.05-0.13. Intestinal bifurcation between pharynx and genital pore and caeca extend a little anterior to posterior extremity overlapped by vitellaria. Acetabulum spherical, smaller than oral sucker, preequatorial, measures 0.07-0.15 in diameter.

Testes, obliquely tandem, median, spherical or oval, postacetabular, intercaecal. Anterior testis smaller than posterior testis and measures $0.03 - 0.24 \times 0.05 - 0.24$. Posterior testis measures $0.078 - 0.25 \times 0.05 - 0.24$. Cirrus sac oval to club shaped, situated in between intestinal bifurcation and acetabulum, measures $0.08 - 0.18 \times 0.03 - 0.11$. Vesicula seminalis bipartite.

Ovary small, oval, submedian or median, attached to acetabulum, measures, 0.05 — 0.17 x 0.04 — 0.10. Receptaculum seminis and Laurer's canal present. Shell gland complex large, uterus pretesticular. Vitellaria consists of large number of follicles extending from posterior margin of acetabulum and reaching almost upto hind end of the body and almost confluent in posttesticular region.

Excretory bladder tubular extending upto posterior border of posterior testis. Eggs large, yellow, oval embryonated, filamented and measures $0.07-0.10 \times 0.03-0.05$

DISCUSSION

This species has been described by Pande (1937) from the intestine of *Channa punctatus* from Handia, Allahabad and Haldwani. Kaw (1950) recorded this species from some other vertebrates. Coil and Kuntz (1960) described it from small intestine of *Channa punctatus* from Dacca (Bangla Desh).

Eight species have been described under the genus Allocreadium Looss, 1902 from India. These include — A. annandalei Southwell, 1913; A. handiai Pande, 1937; A. kosia Pande, 1938; A. schizothoracis Pande, 1938; A. nemachilus Kaw, 1950; A. thapari Gupta, 1950; A. mehrai Gupta, 1956; A. kamalai Gupta, 1956; A. ophiocephali Srivastava, 1960 and A. mukundi Gupta, 1963., Mehra (1966) considered A. thapari and A. ophiocephali conspecific with A. handiai.

From the study of these specimens it is observed that there is variation in the shape of the body (small and oval or large and elongated), in the size of two suckers, the position of testes (varying from very close to acetabulum to midway between acetabulum and hind end of the body), the position of ovary post acetabular or lateral to posterior half of the acetabulum and in the anterior extension of vitellaria upto acetabulum or posterior to it. All these have been considered to be individual variations and the specimens are referred to as *Allocreadium handiai* Pande, 1937.

This species have been recorded for the first time from a number of local fresh water fishes — *Clarias batrachus* (Linn.), *Heteropneustes fossilis* (Bl.), *Channa punctatus* (Bl.) and *Channa striatus* (Bl.) collected at Morena (M.P.) from a pond thus it forms multiple host and new locality reocrd.

Host : Clarias batrachus (Linn.)

Heteropneustes fossilis (Bl.)

Channa striatus (Bl.)

Channa punctatus (Bl.)

Location :

Intestine

Locality : Morena (M.P.)

Family: BUCEPHALIDAE Poche, 1907

Sub family: BUCEPHALINAE Nicoll, 1914

Genus: Bucephalopsis (Diesing, 1855) Nicoll,

1914

Bucephalospsis nekpurensis n.sp.

(Plate II, Fig. 1)

Twenty two specimens of *Xenontodon cancila* (Hamilton), collected from Chambal river in District Morena, were examined for trematode parasites. Six of them harboured twenty seven gasterostomes. These were fixed in 10% formalin for twenty four hours and then were transferred to 5% formalin. The worms were stained in Gower's acidified carmine. Drawings were made with the help of camera lucida. The host specimens were netted from River Chambal at village Nekpur in District Morena, M.P.

Srivastava and Chauhan (1972) reviewed the Indian gasterostomes and restricted the genus *Bucephalopsis* for the cercaria *Bucephalopsis haimeanus* and transferred all the adult species to the genus *Prosorhynchoides* Dollfus, 1929. In the present study the genus *Bucephalopsis* has been considered in the composite sense. All measurements are in millimeters.

DESCRIPTION

Body broad rounded anteriorly, narrow posteriorly, a constriction at the level of posterior border of anterior sucker distinctly marks the sucker area; worm measures 1.139 x 0.527mm; cuticle covered with minute spines, 0.004 mm, anterior sucker discoid, strongly muscular, 0.258 x 0.211; Pharynx 0.068 in diameter, post—equatorial at two third line of the body; oesophagus slender elongate extending anteriorly upto equatorial line leading to anteriorly directed saccular intestine, 0.174 x 0.14; intestine parallal with testes and in median line.

Testes two, oval, postovarian, parallal, on right side of intestine and in line with it, right outer testis immediately behind ovary, measuring 0.174 x 0.14 mm; left testis slightly overlapping inner border of right testis and right border of intestine on inner side, it measures, 0.182 x 0.133 mm; vas efferens of each testis leaves from its left prosterior border and joins in the region of oesophagus to form vas defferens, the latter before entering the copulatory complex expands to form 'spermiducal vescile' (Old name 'false seminal vesicle'/vesicula seminalis externa structure, it enters (?)), it is thin walled spindle shaped structure, it enters cirrus sac and leads into vesicula seminalis which is nearly cylindrical and has wall slightly thicker than spermiducal vesicle,

it continues into pars prostatica, surrounded by prostate glands, and is followed by ejaculatory duct; cirrus sac enclosing all these structures, cylindrical, well developed, it extends anterior to pharynx upto middle of oesophagus and measures 0.38 x 0.102 mm. Genital opening 0.999 mm. from posterior end.

Ovary oblong, 0.163 x 9.079 mm. on right side immediately in front of right testis; oviduct leaves from right posterior border and joins shell gland complex in front of testis; vitelline follicles oval to rounded, large, 12 — 14 in number bunched on either side of posterior border of anterior sucker in front of cosntriction, two vitelline ducts from the vitelline gland travel posteriorly and join to form a common duct before joining shell gland complex, uterus on leaving shell gland complex ascends anteriorly upto anterior sucker and covers all area left of gonads and psoteriorly upto cirrus sac, it descends from behind right side of inner testis to join large muscular metraterm, eggs light yellow, oval, 0.019 x 0.0114 mm. in size. Excretory pore terminal, excretory vesicle tubular.

Host : Xenentodon cancila (Hamilton)

Location : Stomach

Locality: River Chambal in village Nekpur,

District Morena (M.P.)

DISCUSSION

The parasite described above shows dinstict characters like the constriction immediately behind the anterior sucker forming a sort of a collar, presence of gonads in the prepharyngeal zone nearly in the first half of the body, testes being parallel and on the same side and in line with the intestine, presence of spermiducal vesicle (vesicula seminalis externa?) and large vitelline follicles bunched in two groups near the posterior margin of anterior sucker. The spermiducal vesicle described in the parasite is similar to vesicula seminalis externa in Bucephalopsis sinhai Dayal, 1948 and the parasite differs from all the other known species in this character. However, the worm differs from B. sinhai and all other known species in having a collar like constriction, position of gonads in prepharyngeal zone on the side, parallel testes on the same side of intestine parallel with intestine. In view of the distinct characters of the worm it is received in the genus *Bucephalopsis* Diesing, 1855 as a new member and named Bucephalopsis nekpurensis n.sp. after the name of locality from where fish was collected.

Family: BUCEPHALIDAE Poche, 1907

Sub Family: BUCEPHALINAE Nicoll, 1914

Genus: Bucephalopsis (Diesing, 1855)

Nicoll, 1914

Bucephalopsis hardayali n.sp. (Plate II, Fig.2)

Twenty two specimens of a fresh water fish Xenentodon cancila (Hamilton) were collected from the river Chambal, in the district Morena (M.P.) and were examined for digenetic trematodes. Four of them were found infected with twelve of these gastrostomes. These were fixed and stained as described in previously described species. The species is named in honour of Late Dr. Har Dayal Srivastava of I.V.R.I., Izatnagar (U.P.), an eminent and pioneer helminthologist of India.

DESCRIPTION

Small worm with nearly rounded anterior end, posterior end somewhat blunt, 1.235 mm. long and 0.68 mm. broad at equatorial line; cuticle armed with very fine minute spines distributed sparingly, anterior sucker discoid, muscular 0.268 x

0.228 mm. in size; pharynx postequatorial, 0.081 x 0.098 mm; oesophagus broad, 0.319 mm. long, directed obliquely and anteriorly makes a 'U' turn before joining the intestine. Intestine median, equatorial, in line with anterior testis and away and immediately in front of pharynx, 0.228 x 0.174 mm. in size.

Testes two, tandem, anterior testis equatorial between ovary and intestine, 0.228 x 0.129 mm. in size, posterior testis smaller, immediately behind anterior testis and in line with pharynx, 0.269 x 0.201 mm in size; cirrus sac small, broad, extending anteriorly, anterior to pharynx to proximal margin of intestine, vesicula seminalis and pars prostatica well developed, latter surrounded by prostrate glands and followed by ejaculatory duct; genital opening 0.170 mm. from posterior end.

Ovary equatorial, on right side of anterior testis and slightly overlapped by it on its inneer border, 0.190 mm. long 0.125 mm. broad; oviduct from posterior inner border joins ootype immediately behind ovary in front of posterior testis; ootype surrounded by shell glands forming an oblong mass; large vitelline follicles 12 — 14 in number extend from lateral boader of anterior sucker upto line of gonads in first third of body, two vitelline ducts extend posteriorly and medially and join to form a common vitelline duct which joins ootype; uterus extends anteriorly occupies all the area anterior to gonads upto anterior sucker and on left side of intestine, and continues posteriorly between

oesophagus and cirrus sac to join the metraterm which is well developed, muscular; eggs light yellow or brown, 0.019 x 0.011 mm. Excretory opening terminal, excretory vesicle Y—shaped.

Host : Xenontodon cancila (Hamilton)

Location : Stomach

Locality: River Chambal, village Nekpur, District

Morena (M.P.)

DISCUSSION

Bucephalopsis hardayali n.sp. is characterised by the position of the ovary being lateral to anterior testis and in line with intestinal sac, cirrus sac reaching anterior to pharynx upto the beginning of intestinal sac, vitelline follicles being extended from lateral margin of anterior sucker upto anterior margin of ovary and anterior testis and the excretory vesicle being Yshaped. In possession of Y—shaped excretory vesicle the newly described worm resembles B. magnum Verma, 1936 and differs from all the other known species in this character. B.hardayali n.sp. differs from B. magnum and other species of the genus in position of ovary being lateral to anterior testes and in line with intestinal sac and position of ootype being immediately anterior to posterior testis. The characters are sufficiently distinct to receive Bucephalopsis hardayali n.sp. as a new member of the genus. This is the first report of any gasterostome from this region and also from district Morena (M.P.).

Family: BUCEPHALIDAE Poche, 1907

Sub Family: BUCEPHALINAE Nicoll, 1914

Genus: Bucephalopsis (Diesing, 1855)

Nicoll, 1914

Bucephalopsis gaurai Verma, 1936 (Plate III, Figs. 1 — 6)

A large number of worms of this species were collected from the intestine of a fresh water fish, *Pseudentropius gaura* (Hamilton), collected from Chambal river in the district Bhind (M.P.). Since there is great variability in the position of internal organs and considerable variations in the dimensions of the organs, a redescription of the species is given here to clear the things.

DESCRIPTION

Body elongated, slender small to medium sized, aspinose, with its anterior part broad and posterior part narrow and rounded. It measures 2.45 — 5.40 x 0.90 — 2.1 mm. in size. Anterior sucker sub terminal, circular or oval, 0.36 — 0.73 x 0.33 — 0.72 mm. in size. Mouth in centre of body. Pharynx circular,

equatorial, preequatorial or postequatorial, 0.15-0.25 mm. from anterior extremity. Esophagus short and tubular. Intestine saccular, median or a little anterior to median plane. It measures $0.53-1.25 \times 0.25-0.52$ mm. in size at 0.88-1.85 mm. from anterior extremity.

Excretory pore at posterior extremity. Excretory bladder 'Y' shaped.

Genital pore close to posterior extremity, subterminal and surrounded by feebly developed sphincter muscles.

Testes globular or oval, entire, postovarian in same plane behind intestine on either side of pharynx or cirrus sac or on one side directly or obliquely tandem, overlapping or away from each other. The position and size of testes varies from each other. The position and size of testes varies from specimen to specimen. Anterior testis lies from a little anterior to cirrus pouch upto middle region of intestine. It measures 0.20 — 0.60 x 0.25 — 0.42 mm. in size at 0.76 — 2.80 mm. from hind end of body. Posterior testis lies from middle of cirrus pouch upto level of hind end of intestine. it measures 0.30 — 0.48 x 0.25 — 0.50 mm. in size at 0.73 — 1.75 mm. from posterior extremity. Cirrus pouch large, tubular, extending from posterior end of body upto hind end of anterior testis; size and position varies from specimen

to specimen; length of cirrus sac varies from 1/6th to 1/3rd of body length, measuring 0.75 — 1.2 x 0.20 — 0.30 mm. in size. Vesicula seminalis oval and 0.51 — 1.15 x 0.06 — 0.12 mm. in size. Pars prostatica large, globular, 0.08 — 0.21 x 0.05 — 0.10 mm. in size, opening into a short ejaculatory duct, 0.11 — 0.30 mm. in length. A large number of prostate gland cells fill up space in cirrus sac around vesicula seminalis and pars prostatica.

Ovary oval, entrie, prestesticular, situated on right or left side of intestine, anterior or posterior to it, measuring 0.23-0.46 x 0.24-0.35 mm. in size at 1.15-3.11 mm. from posterior extremity. From its posterior side arises oviduct leading to ootype. Mehlis' gland cells surrounding ootype forming a compact oval mass at hind end of ovary and partly covering it. Vitelline glands rounded, follicular, entire or bilobed extending from anterior end of oral sucker or a little posterior to it upto middle of intestine or a little posterior to it. Follicles from 12-20 on each side of body. Two vitelline ducts on either side meet and form a yolk reservoir before opening at ootype. Uterus arises from ootype and extends anteriorly forming a number of coils upto anterior end of oral sucker, then turn towards posterior side to open at genital sinus. Eggs oval, non operculated, $0.021-0.42 \times 0.015-0.024$ mm. in size.

Host : Pseudentropius gaura (Hamilton)

Locaton : Stomach

Locality: Chambal river, District Bhind (M.P.)

DISCUSSION

Verma (1936) described 5 species of the genus Bucephalopsis viz. B. fusiformis, B. gaurai, B. magnum, B. confusus and B. minimus from the intestine of fresh water fishes at Allahabad. Bhalerao (1937) considered B. magnum, B. confusus and B. minimus as synonyms of B. garuai. The minor differnces pointed out as existing between the species and the last three can be ascribed either to difference in age or individual variations. Nagaty (1937) considered B. garuai as a distinct species on the basis of bilobed or double nature of vitelline glands. Srivastava (1938) considered B. magnum as a valid species but maintains that B. contusus and B. minimus are synonymous to B. gaural. Qupta (1956) while redescribing B. magnum and B. karvei agreed with Nagaty in considering B. belonca as a synonym of B. karvei. The author is in agreement with Bhalerao (1937) in considering B. confusus. B. minimus and B.magnum to be synonym of B.gaurai and does not agree with Nagaty, Srivastava and Gupta in considering B. gaurai as distinct species on the basis of bilobed or double nature of vitellaria as it is a variable depicted in figures.

The present specimen in my collection forms the first host and locality record from this region.

Family: BUCEPHALIDAE Poche, 1907

Sub Family: BUCEPHALINAE Nicoll, 1914

Genus : Bucephalus Baer, 1827

Bucephalus kailarasi n.sp. (Plate IV, Figs. 1 — 2)

Three specimens of a gasterostome trematode were collected from the small intestine of a fresh water fish, *Corica soborna* (Hamilton) netted at Chambal river at village Kailaras, in District Morena (M.P.). A detailed examination of the material revealed that it represented a new species of the genus *Bucephalus* Baer 1827. The description given below is based on the study of the stained, permanent whole mount of one of the three specimens which showed little variation. All merasurements are given in millimetres.

DESCRIPTION

Body spinose in the anterior half, elongated, 1.74 long and 0.29 in maximum breadth in the region of ovary and intestinal sac. Rhynchus sucker like, 0.12 x 0.12, with four tentacles, each

carrying near its distal end an inwardly directed blunt process. Mouth opening at the junction of middle and posterior third of body, 1.16 from the anterior end; pharynx globose, 0.08 x 0.08 and muscular; intestine sac like and medial to ovary.

Excretory pore at posterior end of the body, excretory bladder sac—like and extending anteriorly upto a level between the vitellaria and rhynchus.

Tesets two, obliquely placed in the middle of the posterior half of body; anterior testis 0.12 x 0.14 with an anterior concavity accommodating the pharynx; posterior testis 0.14 x 0.12, postero—medial to anterior testis. Cirrus sac large and tubular, 0.26 x 0.08 extending anteriorly upto the middle of posterior testis and containing an oval seminal vesicle, a pars prostatica with diffuse prostate glands and a short ductus ejaculatorius; genital tongue prominent; genital pore sub terminal and ventral.

Ovary entire, pretesticular, oval, 0.12×0.05 , almost marginal in the middle third of body. Uterus extends anteriorly upto a level between the rhynchus and vitellaria, which consist of 12-15 follicles on each side in the pre—ovarian region of body; metraterm runs medial to the cirrus sac and opens into the genital sinus; eggs not observed.

Host : Corica soborna (Hamilton)

Location: Small intestine

Locality: Chambal river, village Kailaras, District

Morena (M.P.)

DISCUSSION

In the genus Bucephalus (Bucephalidae, Gasterostomata, Trematoda), the tentacles associated with the rhynchus show specific differences in shape and number (Chauhan 1954). A key to the species of the genus Bucephalus has been given by Srivastava (1938), Chauhan (1954) and Kakaji (1969). In all, ten species of this genus have been described from India. These are B. aoria Verma, 1936; B. tridenticularia Verma, 1936; B. jagannathai Verma, 1936; B. indicus Srivastava, 1938; B. 1938: B. barina Srivastava. *gangeticus* Srivastava, B.tritentacularis Srivastava, 1963; B. allhabadensis Srivastava, 1963; B. bagarius Srivastava 1963 and B. octotentacularis Kakaji, 1969. Of these ten species, only B. gangeticus Srivastava, 1938 is known to have four tentacles, which are studded with minute pointed spines and are devoid of any processes. Again, in B. gangeticus the gonads are situated close together to the right of the median line and the cirrus sac extends anteriorly up to the anterior level of the anterior testis. None of the species described upto date possess a combination of characters shown by the specimens obtained from *Corica saborna*. There are four tentacles, but each has an inwardly directed process. The new form described here has an entirely different disposition of testes and structure of the tentacles. Therefore, the author regards the present form to be a new species to which the name *Bucephalus kailarasi* is given which is after the name of village Kailaras from where the fish was collected.

Srivastava (1963) considered *B. tridenticularia* Verma, 1936 to be a synonym of *B. indicus* Srivastava, 1938, but Kakaji (1969) has revalidated the two species. Srivastava (1938) did not include *B. aoria* Verma, 1936 in his key as he doubted the validity of this species. However, Yamaguti (1958) has considered *B. aoria* to be a valid species. With the description of the present form, the genus *Bucephalus* now includes 11 species, for the identification of which a key is given below:

KEY TO THE INDIAN SPECIES OF BUCEPHALUS

1.	Tentacles 3 in number	<i>B. tritentacularis</i> Srivastava, 1963
2.	Tentacles 4 in number, each tentacle simple, unbranched and studded with spines.	<i>B.gangeticus</i> Srivastava, 19 3 8
	Each tentacle with an inwardly directed process	<i>B. kailarasi</i> n.sp.
3.	Tentacles 5 in number. Each tentacle with numerous rose—thorn shaped hooks at the base	<i>B. barina</i> Srivastava, 1938
	Each tentacle devoid of hooks but with an apical knob	<i>B. allahabadensis</i> Srivastava, 19 3 8
4.	Tentacles 6 in number. Each tentacle with two later! processes; cirrus sac extends upto anterior margin of posterior testis	<i>B.indicus</i> Srivastava, 19 3 8
	Each tentacle with a single short lateral process; cirrus extends upto anterior margin of anterior testis	<i>B.jagannathai</i> Verma, 1926
5.	Tentacles 7 in number	<i>B.bagarius</i> Srivastava,196 3
6.	Tentacles 8 in number. Tentacle apex like arrow head; cirrus sac extends up to pharynx.	<i>B.tridenticularia</i> Verma, 1936

Tentacle simple and without any process; cirrus sac extends extends up to hind end of ovary.

B.octotentacularis Kakaji, 1969

7. Tentacles as 14 — 22 short processes or fimbriac; testes on two sides or body and separated by pharynx.

B. aoria

•••••

Family: BUCEPHALIDAE Poche, 1907

Sub family: BUCEPHALINAE Nicoll, 1914

Genus : Neobucephalopsis Dayal, 1948

Neobucephalopsis dholpurensis n.sp. (Plate V, Fig. 1)

Only two specimens of this gastrostome trematode were collected from the small intestine of a fresh water fish, *Clupisoma garua* collected from Chambal river.

The fish was catched from the river Chambal at village Sarsana, in the district Dholpur (Rajasthan). The two specimens were of almost equal size and on their detailed study it was observed that they represent a hitherto unknown species of the genus *Neobucephalopsis* Dayal, 1948.

The following description is based only on the stained and whole mount of only one specimen. All measurement are given in millimeters.

DESCRIPTION

Small, linguiform, aspinose body, 3.01 long and 1.26 in maximum breadth in the region of ovary. Rhynchus (anterior sucker) large, subterminal, circular in outline, 0.42 x 0.40. Mouth opening immediately pre—equatorial, 1.46 from anterior end. Pharynx 0.11 x 0.16. Oesophagus short and anteriorly directed. Intestinal caeca 0.42 long, immediately postovarian, saccular and tubular, showing characteristic annulations. Genital pore postero—ventral in front of excretory pore, which is postero—terminal.

Gonads on the same side (left) of the median line. Testes two, almost tandem, postovarian; anterior testis 0.38 x 0.27, slightly larger than the posterior testis, lobed and irregular, anterior margin touching the equator; posterior testis 0.35 x 0.20 and with entire margin. Cirrus sac long and cylindrical, 0.61 x 0.18 (about 20% of body length), extends from hind end of body to the level of middle of posterior testis, and contains a small vesicula seminalis, a large pars prostatica and a short ejaculatory duct. Pars prostatica surrounded by a pack of prostate glands; genital sinus broad.

Ovary roughly pear—shaped, 0.29 x 0.26 in size, and 0.88 (29%) from anterior end of body, immediately antero—lateral to the front end of intestine, Mehlis' gland complex

immediately behind ovary; small but distinct receptaculum seminalis, 0.014 x 0.003 in size; Vitellaria follicular with 14 — 16 lobed follicles on each side between the anterior sucker and ovary. Uterus arises from ootype, ascends up for a small distance cephalad to ovary, bends down to run up to region behind the posterior testis, ascends up again as a coiled tube on the right side of the body to reach up to the middle of the anterior sucker, and then comes down as a highly convoluted tube, running medial to the cirrus sac as a metraterm to open into the genital atrium. Eggs thin—shelled, yellowish brown, and 0.24 x 0.012 in size.

Host : Clupiosoma garua

Location : Small intestine

Locality : Chambal river, Village Sarsana,

District Dholpur (Rajasthan)

DISCUSSION

The genus *Neobucephalopsis* was created by Dayal in 1948 to accomodate *Bucephalopsis* like trematodes with a distinct receptaculum seminis. In a recent review of the Indian gasterostomes, Srivastava and Chauhan (1972) have considered *Neobucephalopsis* as cogeneric with the genus *Bucephalopsis*. They do not consider the presence or absence of receptaculum

seminalis as an important character, because their study has revealed that receptaculum seminalis is present in some specimens, whereas it is not discernible in other specimens of the same series due to its thin and transparent nature and massive develoment of shell glands. The authors find it difficult to agree to this contention, as the fallture to observe the presence of a receptaculum seminalis does not mean its absence, and the presence or absence of a structure never carries the same meaning. If a structure is not discernible in whole preparations, its presence can be verified in sections of the material. This may be the reason that Yamaguti (1958) has accepted *Neobucephalopsis* as a valid genus.

Apart from the type species *Neobucephalopsis bagarius* Dayal, 1948, three other species *N. gauhatiensis, N. eutropiichthis* and *N.pseudotropei* have been described by Gupta (1953) from India. Following the key given by Gupta (1953), the form under reference is comparable with *N.pseudotropei* in having an ovary smaller than testes, and the cirrus sac not extending up to the anterior testis. However, on making a strict comparison of the two species (see Table), the new form differs from *N.pseudotropei* in having a sacculated intestine with a characteristic annulated appearance, the more anterior position of the ovary, relatively shorter size of the cirrus sac, and the extent of the uterus. If

the length of the cirrus sac is not taken into strict consideration, the new form becomes comparable with *N. bagarius* Dayal, 1948. However, the length/breadth ratio, the position of anterior testis, form and disposition of the intestinal sac, and the extent of the cirrus sac (see Table) make the comparison of *N. bagarius* and the new form difficult. Therefore, the form under discussion is considered to be a new species, and it is proposed to name it as *Neobucephalopsis dholpurensis* after the name of District Dholpur.

TABLE SHOWING THE COMPARISON OF NEOBUCEPHALOPSIS DHOLPURENSIS N.SP. WITH N. BAGARIUS DAYAL, 1948 AND N. PSEUDOTROPEI GUPTA, 1953

Structure compard	N. bagarius	N. pseudotropei	N. dholpurensis n.sp.
Skin	Spinose	Spinose	Aspinose
Length/breadth	4.2	2.9	2.4
% distance of mouth opening from anterior end	45.5	50.6	48.5
Anterior testis Posterior testis	1.18 (anterior testis slightly larger)	1.04 (testes almost equal)	1.2 (anteriror testis distinctly larger)
Intestine	Sac like and lying transversely	Simple sac	Saccular, annualated and and and backwardly directed
Ovary	Quite anterior to intestine	In level with pharynx	Antero-lateral to front end of intestine
% distance of ovary from anterior end	50.6	47	59
Length of cirrus sac in relation to body length	1/3	1/4	1/5
Anterior extent of cirrus sac	Upto the anterior testis	Hind end of posterior testis	Middle of posterior testis.

A key to species of *Neobucephalopsis* is given below —

KEY TO THE SPECIES OF NEOBUCEPHALOPSIS

1.	Testes one on either side of cirrus sac	<i>N.gauhatiensis</i> Gupta, 1952
	Testes on one side of cirrus sac	2
2.	Ovary larger than testes	<i>N.eutropiichthis</i> Gupta, 1953
	Ovary smaller than testes	3
3.	Ovary in level with pharynx	<i>N. pseudotropei</i> Gupta 1953
	Ovary anterior to intestine	4
4.	Cirrus sac extending upto anterior testis and about 1/3 of the body length	N.bagarius Dayal, 1948
	Cirrus sac extending up to posterior testis and about 1/5 of the body length	<i>N.dholpurensis</i> n.sp.

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Family: GORGODERIDAE Looss, 1901

Sub family: GORGODERINAE Looss, 1899

Genus: Gorgotrema Dayal, 1938

Gorgotrema barbius Dayal, 1938 (Plate VI, Fig. 1 — 3)

Only seven terematodes of this species wer recovered from the kidneys of a fresh water fish, *Barilius bola* (Hamilton) collected from the river Chambal in District Morena during November, 1996. They belong to family *Gorgoderidae Looss*, 1901 and the sub family Gorgoderinae Looss, 1899. On their detailed study they are identified as belonging to species *G.barbius* Dayal, 1938. The worms are redescribed here furnishing all the details.

DESCRIPTION

The present form *Gorgotrema barbius* is a dorsoventrally flattened trematode of white colour. The cuticle is covered with small scattered spines. The anterior portion of the body is narrow and elongated, while the posterior portion of the body is much expanded and nearly circular. The worm is 4.4 mm. long x 2.95

mm. broad. The narrow anterior part is 1.87 mm. long x 0.96 mm. broad in the region of the genital opening and the posterior expanded portion is 2.53 mm. long x 2.95 mm. broad.

The oral sucker is oval and subterminal. It is 0.47 mm. long x 0.44 mm. wide. The ventral sucker is larger than the oral sucker and oval in shape. It is 0.45 mm. long x 0.47 mm. wide. It is situated at the junction of the neck like a projection and the broad portion of the body, at a distance of 1.57 mm. from the anterior end.

The mouth is a slit—like opening on the ventral side of the oral sucker and opens into a funnel—shaped buccal cavity. The latter leads into a long oesophagus 1.03 mm long x 0.05 mm. broad. The oesophagus bifurcates into two simple and broad intestinal caeca which terminate at a distance of 0.6 mm. from the posterior end of the body.

The excretory pore is situated on the ventral side near the posterior end of the body. It leads into a long tubular bladder extending as far as the posterior follicles of the testes. A number of excretory tubules open on either side of the excretory bladder throughout its entire length.

The female organs consist of an ovary and its duct together with a number of accessory organs associated with it.

The ovary is situated on the right side of the right vetlline gland, and is partly internal to and partly overlaps the right intestinal caecum on the ventral side. It is oval in shape and lies at distance of 2.15 mm. from the anterior end. It is 0.19 mm. long by 0.14 mm. broad. From its left side arises the oviduct which opens into the ootype. The vitelline glands consist of two large undivided follicles. The are situated in the middle of the body, on either side of the ootype, behind the ventral sucker. The right vitelline gland is 0.2 mm. long x 0.12 mm. broad and is situated at a distance of 2.1 mm. from the anterior end. The left vitelline gland is irregular in outline and is 0.18 mm. long x 0.17 mm. broad. It is situated at a distance of 2.16 mm. from the anterior end. The ducts from the two glands open separately at the ootype. A large number of unicellular shell—glands, each with a large nucleus, surround the ootype.

The genital opening is situated between the oral sucker and the intestinal bifurcation, at a distance of 1.18 mm. from the anterior end and 0.3 mm. in front of the intestinal bifurcation. It leads into a common genital atrium into which open both the male and the female genital ducts.

The male reproductive organs consist of a large number of small rounded or oval testes. They are scattered irregularly in the anterior half of the borad portion of the body, behind the ovary and between the intestinal caeca. The number of testes is between 34 and 40. In the type specimen the number is 38.

The cirrus sac is absent. The vesicula seminalis lies freely in the parenchyma and is oval in shape. It is 0.075 mm. long x 0.06 mm. wide and opens into a short ejaculatory duct which is 0.03 mm. long. The latter opens into the genital atrium on the left side of the opening of the female duct.

The uterus arises from the posterior side of the ootype between the openings of the vitelline ducts. It runs backwards forming coils mainly between the intestinal cacca, but also extends over the latter on the ventral side. Anteriorly it runs dorsal to he ventral sucker to open at the genital atrium on the right side of the opening of the male duct.

The eggs are oval in shape with a thin light—brown shell. They measure 0.031-0.035 mm. x 0.022-0.24 mm.

The distinguishing characters of this species may be summarised as follows:

- Body flat, divided into an anterior elongated neck like portion and a posterior broad circular portion.
- 2. Cuticle covered with small scattered spines.
- 3. A funnel—shaped buccal cavity present. Oesophagus long,

intestinal caeca simple and broad.

- 4. Excretory bladder tubular with lateral branches.
- 5. Genital opening anterior to intestinal bifurcation.
- 6. A common gential atrium both for male and female ducts present.
- 7. Testes 'follicular, in large numbers (34 40), scattered in the anterior half of the broad portion of the body.
- 8. Uterine coils posterior to ootype, most intercaecal.

Host : Baralius bola (Hamilton)

Location : Kidney

Locality: Chambal river, District Morena (M.P.)

DISCUSSION

The present specimens belong to the family Gorgoderidae and the sub family Gorogderinae, as clearly appears from the description given above. It differs from all the known genera of the sub family (*Gorgodera, Phyllodistomum, Macia* and *Xystretum*) in the possession of funnel—shaped buccal cavity, in the position of the genital pore, in the shape of the excretory bladder, in the number and configuration of the testes. *Gorgodera* is the only genus in which the number of testes is more than two, but in *Gorgodera* the tetstes are nine in number and are arranged in

two longitudinal rows one behind the other, one row consisting of four and the other of five testes. In *Gorgodera*, the testes are in large numbers (34—40) scattered irregularly in the anterior half of the broad portion of the body. The difference in the number and the configuration of the testes, the position of the genital pore, and the possession of the buccal funnel is enough to identify them as belonging to *Gorgotrema barlius* Dayal, 1938.

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Family: GORGODERIDAE Looss, 1901

Sub family: GORGODERÍNAE Looss, 1899

Genus: *Phyllodistomum* Braun, 1899

Phyllodistomum chandrai n.sp. (Plate VII, Fig. 1)

Seven specimens of this digenetic trematode were found from the urinary bladder of a fresh water fish, *Gudusia chapra* (Hamilton) collected from the river Chambal in the District Morena during October, 1996. It is considered as a new species and is named *Phyllodistomum chandrai* in honour of an eminent helminthologist (Retired) Dr. Ravi Chandra (Indian Veterinary Research Institute, Izatnagar). All measurements are given in mm.

DESCRIPTION

Body flattened, aspinose and with an anterior narrow portion and a posterior expanded portion. Body length 2.05 and maximum breadth 0.8 in the region of ovary. Narrow anterior part of body meausres 1.05×0.44 , while the posterior expanded part is 1.00×0.80 . Oral sucker terminal and circular, 0.25×0.25 ,

and larger than acetabulum (0.22 x 0.22) lying in the posterior region of the narrow anterior part of body, 0.82 from the anterior end. Mouth near the anterior end of oral sucker. Pharynx absent. Oesophagus small, looped and bifurcating into two simple unbranched intestinal caeca reaching up to some distance short of the posterior end of body. Excretory bladder tubular. Excretory pore near posterior end of body.

Testes two, obliquely placed in the middle region of expanded part of body and irregular in shape. Anterior testis 0.092 x 0.072 and 1.37 from anterior end. Posterior testis larger, 0.13 x 0.09, deeply lobed. Cirrus sac absent. Vesicula seminalis postbifurcal and bipartite. Genital pore immediately postbifurcal.

Ovary 0.164×0.136 , with large lobes, postacetabular, immediately anterior to posterior testis and 1.2 from the anterior end of body. Receptaculum seminalis absent. Vitellaria as two compact structures between ovary and acetabulum. Uterus mostly occupies the posterior half of the expanded part of body and extends into extracaecal fields. Anteriorly the uterus runs dorsal to the acetabulum to open at the genital pore. Eggs large, oval 0.056×0.24 in size, and embryonated.

Host : Gudusia chapra (Hamilton)

Location: Urinary bladder

Locality: Chambal river, District Morena (M.P.)

DISCUSSION

A total of 15 species (13 from fishes and 2 from amphibians) of the genus Phyllodistomum have been reported from India. Rai (1971) has critically reviewed the Indian species of this genus and has shown that its various species can be divided into three distinct groups on the basis of the relative size of oral and ventral suckers. He has given sufficient reasons for the suppression of a number of species on grounds of synonymity. The form under reference has an acetabulum smaller than the oral sucker, a condition that occurs in *P. vachius* Dayal, 1949, P. vittatusi Gupta, 1953 and P. chauhani Motwani and Srivastava, 1961 amongst the reported Indian species of the genus Phyllodistomum. A comparison of the new form with P. vachius, P. vittatusi and P. chauhani is presented in Table I from a perusal of which it would appear that P. vachius, P. vittatusi and P. chauhani are identical. This point of view is in complete agreement with that of Rai (1971) who arrived at the same conclusion after a critical study of various species of Phyllodistomum from fishes. The new form differs from P. vachius. P.vittatusi on account of possessing the following combination

of distinguishing characters:

- 1. The narrow anterior part of the body is half of the total body length, which is more than twice the maximum breadth.
- 2. The testes do not have entire margins. The anterior testis is smaller than the posterior one and relatively more posterior in position and situated at the junction of middle and posterior third of body.
- Acetabulum is slightly smaller than the oral sucker and it is relatively more posterior (at 40% of body length from anterior end) in position.
- 4. Ovary is just behind the vitelline gland on one side (not by its side).
- 5. Vesicula seminalis is bipartite.

These characters justify the creation of a new species for the reception of the new form, which is named *Phyllodistomum chandrai* on account of having relatively longer anterior part in relation to the total length of the body. The occurrence of *Phyllodistomum* in *Gudusia chapra* constitutes a new host record.

TABLE — I. COMPARISON OF *Phyllodistomum chandrai* n.sp. WITH *P. vachius, P. vittatusi* and *P. chauhani*.

	<i>P. vachius</i> Dayal, 1949	<i>P. vittatusi</i> Gupta,1953	<i>P. chauhani</i> Motwani & Srivastava, 1961	<i>P. chandrai</i> n.sp.
Host	Eutropiichthys vacha, Mystus aor, Mystus seenghala		Mystus aor, Mystus seenghala	Gudusia chapra
Length/breadth	1.42	1.42	1.38	2.50
Narraw anterior part as % of body length	34%	38.4%	30.4%	51%
Oral sucker: accetabulum	1.34	1.47	1.3	1.1
Position of acetabulum at % of body length from anterior end	34%	38.4%	33%*	40%
Position of anterior testis at % of body length from anterior				
end	55%	53%	45%*	66%
Size of Ovary	Lager than right testis	Lager than testes	_	Lager than testes
Position of ovary	Left of vite— lline gland	Left of vitellite gland	By the side of vitelline gland	Behind the vitelline gland
Ovary from anterior end Viscula seminalis	47% Not bipartite 0.035—0.038 x 0.027—0.29	49% Not bipartite 0.021—0.031 x 0.018—0.029	46.6% Not bipartite 0.12** in diamter (round?)	60% Bipartite 0.056 x 0.024

^{*} Calculated from figure

^{**} Doubtful observation by Motwani and Srivastava (1961)

Family: GORGODERIDAE Looss, 1901

Sub family: GORGODERINAE Looss, 1899

Genus: *Phylodistomum* Braun, 1899

Gorgotrema agarwali n.sp. (Plate VIII, Fig. 1)

Only two worms of this species were collected from the urinary bladder of *Rita rita* (Hamilton) procured from the Chambal river in district Bhind. On detailed study these were found new to science hence are designated as a new speecies. The species is named *P. agarwali* n.sp. and is described as under.

DESCRIPTION

Body spatulate, 4.23 mm. long and 2.23 mm. wide just behind testicular region of body; anterior part narrow and elongated, 1.8 mm. long and 1.10 mm. wide. The posterior part expanded and nearly circular, 2.52 mm. long and 2.23 mm. wide. Oral sucker globular, terminal, 0.5 mm. in diameter. Pharynx absent; oesophagus tubular, 0.19 x 0.08 mm. in size. It bifurcates into two intestinal caecae, sinuous, extending backwards

marginally to terminate 0.25 mm. from hind end. Ventral sucker circular, equal to oral sucker, 0.5 mm. in diameter, located 1.35 mm. or nearly 1/3rd of body length from anterior extremity.

Excretory pore dorsal; bladder long, tubular, extending as far as testes. Genital pore median situated between intestinal bifurcation and ventral sucker at a distance of 0.95 mm. from anterior extremity.

Testes lobed, intercaecal, subequal, postequatorial, symmetrical in broadest part of hind body and separated by uterine coils; situated at a distance of 2.75 mm. from anterior end and 0.28 mm. behind the ovary; right testis larger than left and 0.53 x 0.40 mm. in size, left testis 0.44 x 0.42 mm. in size. Cirrus sac absent. Vesicula seminalis free in parenchyma between intestinal bifurcation and ventral sucker, sac like and measures 0.15×0.08 mm. in size.

Ovary lobed, pretesticular, 0.42 x 0.30 mm. in size and situated on left side of vitelline gland at a distance of 0.2 mm. from the posterior margin of ventral sucker. From its right side arises oviduct leading to ootype. Vitelline glands consist of two divided follicles lying behind ventral sucker, one on either side of ootype at a distance of 1.95 mm. from anterior extremity; right vitelline gland 0.10 x 0.028 mm. and left 0.1 x 0.029 mm. in size. Ducts from two glands open separately at ootype. A larg number of unicellular glands surround ootype. Uterus arises from

hind end of ootype and runs backwards forming coils filling up nearly all space of body posterior to vitelline glands both intra and extra caecally also extending dorsal to ventral sucker to open at genital pore. Eggs oval non—operculated $0.039-0.052 \times 0.019-0.034$ mm. in size.

DISCUSSION

The new form belongs to the genus *Phyllodistomum* Braun, 1899. The following species of the genus *Phyllodistomum* have been described so far from fresh water fishes of India viz. *P. lewisi* Srivastava, 1958, *P. vachius* Dayal, 1949; *P. loossi* Kaw, 1950; *P. singhiai* Gupta 1951; *P. vittatusi* Gupta 1954 *P. parorchim* Jaiswal, 1957. *P. indianum* Jaiswal, 1957, *P. chauhani* Motwani & Srivastava, 1971; *P. tripathi* Motwani & Srivastava, 1961 and *P. srivastavai* Rai, 1964. The new form is distinct from all the above species of *Phyllodistomum* with the exception of *P. loossi* in having suckers of equal size. The new form differs from *P. loossi* in having posterior part disc like separated from much narrower anterior portion, in having symmetrical testes and in having ovary anterior to testes.

Therefore, it is regarded a new species with the specific name *P. agarwali* n.sp. in honour of Dr. S.C. Agarwal, Head, Deptt. of Zoology, Bipin Behari (P.G.) College, Jhansi and a helminthologist.

Host : Rita rita (Hamilton)

Location : Urinary bladder

Locality: Chambal river, District Bhind.

Family: GORGODERIDAE Looss, 1901

Sub family: GORGODERINAE Looss, 1899

Genus: *Phyllodistomum* Braun, 1899

Phyllodistomum tripathi Motwani & Srivastava, 1961 (Plate IX, Figs. 1—4)

A large number of specimens of this form were recovered from the intestine of a fresh water fish, *Barilius barita* (Hamilton) and five immature specimens from the intestine of *Pseudeutropius garua* (Ham.). Both fishes were collected from Chambal river in the District Bhind. As this species has not hitherto been described adequately, it is therefore redescribed.

DESCRIPTION

Body dorsoventrally flattened, spatulate, 1.55-4.58 mm. long and 0.74-2.02 mm. wide at its broadest point in hind body. Forebody cylindrical, narrow, $0.90-2.7 \times 0.53-0.80$

mm. in size and posterior portion broad and foliate. $0.69-2.0 \times 0.74-2.02$ mm. in size. Three pairs of feebly developed semicircular puckerings present on lateral sides of hind body. Posterior end of body with well-defined notch. Oral sucker terminal, oval, $0.19-0.50 \times 0.19-0.45$ mm. in size. Esophagus long, narrow, straight or curved, 0.11-0.45 mm. in length, bifurcates into two intestinal caeca that terminate at 0.17-0.50 mm. from hind end of body. Caeca broad with crinkled margins, and in some immature specimens very close together or apart from each other. Ventral sucker spherical larger than oral sucker. 0.3-0.6 mm. in diameter in anterior third of body at 0.67-2.0 mm. from anterior extremity.

Excretory pore dorsally at posterior end of body. Excretory bladder tubular extending upto hind margin of ventral sucker then dividing into right and left branches. Genital pore median, between intestinal bifurcation and ventral sucker at 0.43 — 1.40 mm. or nearly 1/4th from anterior extremity.

Testes deeply lobed, subequal, intercaecal, postequatorial, either close to posterior extremity or quite anterior to it, diagonal or symmetrical in broadest part of hind body well separated by uterine coils. Right testis at level of ovary but not in close proximity, $0.20 - 0.48 \times 0.20 - 0.60$ mm. in size at 0.30 -

1.12 mm. from hind end. Left testis slightly larger than right located near termination of caeca or slightly anterior to it, 0.25 - 0.55 x 0.20 - 0.50 in size at 0.15 - 0.90 mm. from hind end. Cirrus sac absent. Vesicula seminalis saccular 0.08 - 0.25 x 0.03 - 0.13 mm. in size.

Ovary submedian, prestesticular and consists of 4-5 lobes, situated just behind left vitelline gland, 0.10-0.25 x 0.09-0.25 mm. in size at 1.06-2.8 mm. from anterior extremity. Vitelline glands two, bilobed masses lying asymmetrically on both sides of body just behind ventral sucker close in front of ovary; right vitelline gland measures 0.03-0.12 x 0.11-0.31 mm. in size and left vitelline gland, 0.03-0.10 x 0.11-0.32 mm. in size. Two vitelline ducts run transversely and unite to form a common yolk reservoir from where a median vitelline duct orginates and joins Mehlis' gland. Uterus arises anteriorly from ootype, then bends ventrally and subsequently filling posteriorly hind body inter and extracaecally. Anteriorly it runs dorsal to ventral sucker to open at genital pore. Eggs oval, non—operculated, $0.051-0.075 \times 0.025-0.049 \text{ mm}$. in size.

The present specimen in my collection forms the first host and locality record from this region.

Host : Barilius barila (Hamilton)

Location: Intestine

Locality: River Chambal, District Bhind (M.P.)

DISCUSSION

The present form belongs to *Phyllodistomum* sp. Bhalerao, 1937 and *P. tripathi* Motwani & Srivastava, 1961 but however differs from both of them, in the shape and position of testes and ovary in having a well defined posterior notch and in the bilobed nature of vetellaria. These differences are considered variations within the species.

Family : HEMIURIDAE Luhe, 1901

Sub family: HALIPEGINAE Ejsmont; 1931

Genus: Genarchopsis Ozaki, 1925

(Syn. Progonus Looss, 1899

preoccupied)

Genarchopis dwivedii n.sp.

(Plate X, Figs. 1 — 5)

A large number of digenetic trematodes belonging to this species were recovered from the stomach of a fresh water fish, *Channa punctatus* (Bloch.). The fish was obtained from the fish market at Morena. On enquiry, the fish shop owner told that the fishes are a part of catch from the river Chambal. On detailed study the worms were found belonging to a new species and are described here.

DESCRIPTION

Body fusiform with rounded extremities, $1.3-3.33 \times 0.68-1.02$ mm. in size. Oral sucker subterminal, oval, $0.22-0.45 \times 0.27-0.46$ mm in size. Prepharynx absent; pharynx well developed, $0.05-0.12 \times 0.06-0.16$ mm. in size; esophagus absent; esophageal pouch arises from junction of pharynx and intestinal bifurcation, $0.12-0.22 \times 0.06-0.07$

mm. in size. Intestinal caeca crenated in outline, run in a wavy course to hind end of body and united together in vitellaria region. Ventral sucker larger than oral sucker, spherical, equatorial or postequatorial, 0.47-0.74 mm. in diameter at 0.82-1.83 mm. from anterior extremity.

Genital pore median, close behind pharynx at a distance of 0.47 — 0.57 mm. from anterior extremity.

Excretory pore dorsally at posterior end of body. Excretory bladder Y—shaped with an unbranched median stem dividing into two cornua extending upto ventral sucker uniting dorsal to pharynx.

Testes oval, postacetabular, subequal, entire, caecal and somewhat symmetrical or oblique in position. Left testis $0.13-0.31 \times 0.10-0.26$ mm. in size and lies slightly nearer ventral sucker than right testis which measures $0.10-0.24 \times 0.09-0.24$ mm. in size. Cirrus sac absent. Vesicula seminalis elongated, S—shaped or somewhat winding in a coiled tube filled with sperms lying free in parenchyma far anterior of acetabulum and close to intestinal bifurcation. It measures $0.40-0.55 \times 0.05-0.06$ mm. in size. Pars prostatica tubular 0.06-0.1 mm. long enclosed in a thin walled sac surrounded by a large number of prostate gland cells. Ejaculatory duct 0.05-0.06 mm long

opening in terminal part of uterus.

Ovary oval, postacetabular, entire, larger or smaller than testes, either close or away behind right testis. It measures 0.13 - 0.20 x 0.12 - 0.22 mm. in size at 0.25 - 0.47 mm. from hind end of body. Oviduct arises from right side of ovary and oens at ootype. Receptaculum seminis well developed oval, lying postero dorsal to ovary $0.06 - 0.15 \times 0.13 - 0.15$ mm. in size. Vitellaria consists of two large compact or lobed masses lying symmetrically or obliquely tandem in posterior region of body. Right vitelline gland measures, $0.17 - 0.23 \times 0.09 - 0.15 \text{ mm}$. in size while left vitelline gland measures 0.13 - 0.23 x 0.12 — 0.18 mm. in size. Vitelline ducts arise from each vitelline gland and the two unite each other before opening at ootype. It lies just behind ovary and partly overlapped by it, 0.06 - 0.14 x 0.11 - 0.15 mm. in size. Uterus arises from dorsal side of ootype and forms closely packed transversely coils occupying mostly preacetabular area. The coils of the uterus are mainly internal and external to caeca. The terminal part of uterus receives ejaculatory duct forming hermaphrodite duct which opens at genital pore. Eggs oval with a polar filament at one end, 0.035 - 0.06 mm. in length. Eggs measures 0.04 - 0.05 x 0.02 -0.25 mm. in size.

DISCUSSION

Srivastava (1933) considered that the genus Genarchopsis Ozaki, 1925 is identical and synonymous with the genus Progonus Looss, 1899. In the same year he created another genus Ophiocorchis with the type species O. lobatum under the sub family Derogenetinae of the family Hemiuridae Luhe, 1901. He distinguished the genus Ophiocorchis from Progonus in the possession of a well developed globular pars porstatica, a large highly muscular metraterm, a protrusible hermaphroditicus and oesophageal pouch. Yamaguti (1958) considered the genera Progonus Looss, 1899; Genarches Looss, 1902 and Ophiocorchis Srivastava, 1933 as a synonym of Genarchopsis Ozaki, 1925. The author is in agreement with Yamaguti as the characters separating the genus Ophiocorchis from Progonus are variable.

The new form is referred to the genus *Genarchopsis* Ozaki, 1925 of which seven species are known from fresh water fishes of India. The new form differs from all the known forms of the genus in the possession of a well developed receptaculum seminalis and in having genital pore close behind the pharynx. The new form resembles *G. lobatum* (Syn. *Ophiocorchis lobatum*); *G. singularis* (Syn. *O. singularis*) and *G. faruquis* (Syn

O. faruquis (Syn. O. faruquis) in the possession of an oesophageal pouch. The new form differs from G. lobatum and G. singularis in haing testes symmetrical instead of one behind the other. Further the new form differs from G. lobatum in having entire or slightly lobed vitellaria instead of lobed glands and from G. singularis in the non extension of uterine coils upto hind end of vitellaria. The new form bears a very close resemblance to G. faruquis but differs from it in not having Mehlis' gland complex anterior to ovary. These differences are sufficient to create a new species G. dwivedi n.sp., It is named in honour of my houourable Supervisor Dr. U.K. Dwivedi.

Host: Channa punctatus (Bloch.)

Location : Stomach

Locality: Chambal river, District Morena (M.P.)

Family : HEMIURIDAE Luhe, 1901

Sub family: HALIPEGINAE Ejsmont, 1931

Genus : Genarchopsis Ozaki, 1925

(Syn. Progonus looss, 1899

preoccupied)

Genarchopsis piscicola Srivastava, 1933. (Platte XI, Fig. 1)

The present study is based on eight specimens of this species collected from intestine of *Channa punctatus* (Bloch.). 360 specimens of *Channa punctatus* (Bl.) were procured from ponds at Jaigaon Bilsahi in District Bhind and dissected, of which intestine of four fishes were found infected with *Genarchopsis*.

DESCRIPTION

The body is small, fusiform, aspinose, muscular and measures $1.26-2.62 \times 0.47-0.89$. The oral sucker is subterminal, cup like and measures $0.32-0.40 \times 0.32-0.50$. Acetabulum is large, postequatorial, well developed, muscular, almost spherical, measuring $0.60-0.87 \times 0.61-0.87$. The prepharynx is absent. Pharynx present, small and measures 0.11

 $-0.13 \times 0.02 - 0.19$. Oesophagus absent. Intestinal caecae long and sinuous, extending upto posterior margin of body where they unite.

Testes oval, postacetabular, slightly obliquely tandem, extracaecal and anterior testis measures $0.24-0.37 \times 0.17-0.28$ and posterior testis $0.24-0.37 \times 0.17-0.33$ respectively. The cirrus sac absent. Pars prostatica is tubular and convoluted. The ejaculatory duct is short and opens along with metraterm into a short hermaphroditic duct.

Ovary small, postacetabular, intercaecal, spherical, situated almost at the level of posterior testis and measuring $0.15-0.23 \times 0.12-0.33$. The uterine coils are intercaecal, extending posteriorly upto the hind border of the testes. The left vitelline follicles measure $0.12-0.33 \times 0.93-0.42$, while right follicles measure $0.18-0.52 \times 0.07-0.28$. The genital pore just below pharynx near the intestinal bufurcation.

DISCUSSION

Looss (1899) crected the genus *Progonus* for *Mulleri* Levinsen, 1881. He (1902) renamed it as *Genarches* thinking the name *Progonus* as preoccupied by the insect genus *Progona* Berg, 1886. Fuhrmann (1904, 1928), Odhner (1905) considered *Progonus* as valid. Ozaki (1925) proposed a new genus

Genarchopsis to accomodate his new species G. goppo Srivastava, H.D. (1933) while accepting the name Progonus valid, considered the genus Genarchopsis as synonym of the former. He also crected a new genus Ophiocorchis to accomodate his new species O. lobatum. Yamaguti (1958, 1971) considered the genera Progonus, Genarches, Ophiocorchis as congeniric with Genarchopsis, the former two being, in his opinion, preoccupied. This arrangement is more or less being followed by the subsequent workers. Rai (1971) made a detailed study of various Indian species related to the genus Ophiocorchis and Genarches and came to the conclusion that all Indian species are synonym of G. goppo Ozaki, 1925. He, however, did not deal with the question of the validity of the genus Progonus. Srivastava, H.D. and Sahai (1978) tried to revalidate the genus Ophiocorchis. The genus *Progonus* is not preoccupied as generally believed. According to Article 56 of International Rules of Zoological Nomenclature, the genera Genarchopsis, and Ophiocorchis have therefore been related to the genus Progonus.

The trematode under discussion has been compared with the valid species of genus *Genarchopsis* Ozaki, 1925 namely *G. ovacaudatum, G. piscicola* and *G. dasus.* It differs from *G. ovacaudatum* in the length and maximum width of the body, size of ovary, ratio of suckers and extension of uterine coils. It also

differed from *G. dasus* (Gupta, 1951) in the length and maximum width of body, length and width of oral sucker, ratio of suckers and measurement of vesicula seminalis.

However, the worm approaches more closely to *G. piscicola* Srivastava, 1933 in the extension of uterine coils and principal body measurement, except for the differences in the length of the body, the ratio of suckers and the nature of the uterine coils. These variations are minor ones and do not suggest the proposition of a new species and so the present worms are referred to as *Genarchopsis piscicola* Srivastava, 1933.

Host: Channa punctatus (Bl.)

Location: Intestine

Locality: Bhind (M.P.)

Family : HEMIURIDAE Luhe, 1901

Sub family: HALIPEGINAE Ejasmont, 1931

Genus: Genarchopsis Ozaki, 1925

(Syn. Progonus Looss, 1899

preoccupied).

Genarchopsis singularis Srivastava, 1933

(Plate XII, Fig. 1)

specimens of *Channa punctatus* (Bl.) and 360 specimens of *Channa striatus* (Bl.) were examined during present study. Out of these four and one specimen were found infected respectively with *Genarchopsis singularis* Srivastava, 1933. In all ten worms were collected from the intestine of hosts. The fishes were procured from a pond at Jaigaon District Bhind (M.P.).

DESCRIPTION

Body small, oval, $0.98 - 3.32 \times 0.49 - 0.86$ with maximum breadth at acetabular zone. Oral sucker oval, subterminal, $0.13 - 0.33 \times 0.19 - 0.37$. Pharynx oval, $0.08 - 0.23 \times 0.07 - 0.10$. Oesophagus small.

Testes symmetrical, postacetabular, oval, overlapping intestinal caeca, measuring $0.11-0.21 \times 0.09-0.13$ and 0.11

- 0.20 x 0.08 - 0.17 respectively. Cirrus sac absent.

Ovary small, spherical, medain, posttesticular, lying in the hind part of body, anterior to vitelline follicles, $0.067-0.22 \times 0.087-0.16$. Shell gland complex postovarian. Uterus with transverse coils extending posteriorly upto vitelline zone which continues anteriorly as metraterm and opens into pars prostatica. Eggs yellowish, oval, $0.021-0.037 \times 0.011-0.015$ with a filament on one side. Vitellaria two, compact, oval glands one on either side in posterior most part of the body.

Excretory bladder Y—shaped with arms anastomosing dorsal to oral sucker.

DISCUSSION

Chauhan (1953) in the comprehensive work on the family Hemiuridae maintained the genera *Progonus* and *Ophiocorchis* synonym of *Genarches* and transferred their species under it. Yamaguti (1958) synonymised the genus *Ophiocorchis* Srivastava, 1933 (*Progonus* Looss, 1899, Preoccupied; *Genarches* Looss, 1902 Preoccupied) with *Genarchopsis* Ozaki, 1925.

Srivastava (1933) described *Ophiocorchis singularis* from the intestine of *Channa marulius* at Allahabad. Gupta (1951) collected some specimens from *Channa punctatus* at Lucknow and Sharanpur, U.P. and referred them to as new species *Ophiocorchis*

indicum. Chauhan (1954) remarked that the differences enumerated by Gupta do not merit the establishment of a new species and the two species should be considered identical.

The present specimens have been collected from *Channa punctatus* and *Channa striatus* from a pond at Jaigaon in District Bhind (M.P.) and combine the characters of both the species. Thus, it is evident that *O. indicum* is conspecific with *O. singularis* as suspected by Chauhan (1954). The present collection, however forms a new locality record.

Host : Channa punctatus (Bl.)

Channa straiatus (Bl.)

Location: Intestine

Locality: Jaigaon, District Bhind (M.P.)

Family : HEMIURIDAE Luhe, 1901

Sub family: HALIPEGINAE Ejsmont, 1931

Genus: Genarchopsis Ozaki, 1925

(Syn. Progonus Looss, 1899

preoccupied)

Genarchopsis goppo (Tubangui) Ozaki, 1925 (Plate XIII, Fig. 1)

On several occasions the fish species *Channa punctatus* (Bloch) = *Ophiocephalus punctatus* (Bloch), the smaller form and *C. striatus* (Bloch), the larger form, collected from river Chambal in district Bhind revealed the presence of a parasite belonging to the species *Genarchopsis goppo* (Tubangui) Ozaki, 1925, the site of infection being intestine. The number of worms collected from a host was usually one or two. Therefore, an attempt has been made to restudy these specimens for variations and to discuss the validity of various species.

DESCRIPTION

The account is based on about three dozen mounted specimens (both mature and immature and sectioned) collected

from Channa punctatus, C. straiatus, R. cyanophlyctis and T. piscator. The aspinose body (Fig. 1) is cylindrical, elongate, oval with an attenuated anterior and a blunt posterior end measuring 2.31 - 2.65 mm. $\times 0.63 - 0.91$ mm.

The oral sucker is subterminal, oval and measures 0.14 - 0.26 mm x 0.23 - 0.32 mm. The ventral sucker is well developed, larger than oral sucker, located in the middle third of body, sometimes displaced during fixation and measures 0.42 -0.67 mm. x 0.45 - 0.68 mm. in size. The prepharynx is absent, the pharynx is round to oval, at times overlapped by oral sucker and measures 0.06 - 0.08 mm. x 0.08 - 0.09 mm. A small oesophagus, better seen in live specimens, measures 0.06 — 0.08 mm. In fixed specimens, however, due to contraction it seems to be absent. Further, a small pouch (oesophagean pouch of Srivastava, 1933) not well developed in some specimens, is present at the level of the intestinal bifurcation. The oesophagus, when studied in a live contracted specimen, assumes a pouch or a bulb shape at the intestinal bifurcation. Further, the histological details of this region, as revealed by serial sections, show identical structure of oesophageal pouch and intestinal caeca. The intestinal caeca is sinuous, with its outer margin smooth, crenated or lobed and unite with one another in the hind region of the body.

The roughly equal testes are round, elongate or oval in shape, symetrically or slightly asymetrically located behind the ventral sucker. They are mostly intercaecal but sometimes, overlapped by the intestinal caeca. The testes measure 0.16 — 0.31 mm x 0.12 — 0.16 mm. A thick walled convoluted vesicula seminalis with well marked lumen inside, is located free in the parenchyma. The tubular pars prostatica is sometimes curved and surrounded by well developed prostate gland cells. It opens at the terminal part of the metraterm by short ejaculatory duct. No sac like structure, as described by Gupta (1951) in some species of *Genarchopsis*, surrounds the vesicula seminalis or pars prostatica.

The round or oval ovary is median or dextrally placed in between the testes and vitelline follicles. The Mehlis' gland complex is well developed and situated near or slightly away from the ovary. In young specimens, however, it is poorly developed. The short oviduct opens at the ootype from where a prominent Laurer's canal arises. The receptaculum seminis uterinum, simulating a true receptaculum seminis, is present. The uterus is transversally arranged in the inter—caecal space but also extends in the extracaecal field or overlapping the intestinal caeca upto the shell gland mass. Anterior to the ventral sucker, it forms a short metraterm behind the intestinal bifuration in which opens

the pars prostatica to give rise a ductus hermaphroditicus which terminally opens by a short, stumpy, contractile, genital papilla, well marked in some specimens into a genital atrium. The genital pore and genital papilla have striated cuticle. Further, the genital pore is surrounded by glands and is variable in its position. In well pressed specimens it is medially opposed to the intestinal bifurcation but in contracted specimens, lie even anteriorly, slightly lateral to the oesophageal pouch or at the level of the oesophagus. The eggs are oval, operculated, filamentous measuring $0.016-064 \times 0.023-0.031$ mm, the long polar filaments measure 0.19-0.31 mm.

The vitelline follicles consist of two glandular masses located roughly symmetrical or asymmetrical behind the ovary. They are entire, lobed or with crenated margins. The common vitelline duct, from the vitelline reservoir, opens at the ootype.,

The 'Y' shaped excretory bladder opens out by a terminal excretory pore which is surrounded by deeply staining cells. The excretory canals, one on each side of the body, extend upto the pharyngeal region where they unite together.

Host: Channa punctatus (Bloch)

Location: Intestine

Locality: River Chambal, District Bhind (M.P.)

DISCUSSION

The genus Genarchopsis was crected by Ozaki (1925) with G.goppo as the type species. Earlier Looss (1899) created the genus Progonus to include Genarchopsis mulleri Levinson, 1881. Subsequently, Srivastava (1933) regarded Genarchopsis synonym of Progonus and discribed P. piscicola and P. ovocaudatum as additional species. Further, Srivastava (1933) created the genus Ophiochorchis to include O. lobatum and O. singularis on account of the presence of an oesophageal pouch, Gupta (1951) added three more species viz., O. dasus, O. inducus and O. faruquis and amended the diagonosis of the genus Ophiochorchis. Chauhan (1953) in the comprehensive work on the family Himuroidae maintained the genus Genarchopsis, Progonus and Ophiochorchis though he doubted the validity of certain species of the genus Genarchopsis and Ophiochorchis. Further, he pointed out the wrong nomenclature coined by Gupta (1951) for O. dasus and O. faruquis. Skrjabin et.al. (1955) considered the genus Progonus and Ophiochorchis synonym of Genarches and maintained the genus Ophiochorchis and its five species valid because of presence of oesophageal pouch. Yamaguti (1958) in his monograph 'Systema Helminthum' considered the genus Genarchopsis valid with Progonus and Ophiochorchis as its synonym, taking in view the caudal

anastmosis as common feature in the three genera. He further enlisted 11 species under the genus Genarchopsis of which eight were transferred from the genera Ophiochorchis and Progonus. The writer fully agree's with Yamaguti (1958) and regards Ophiochorchis and Progonus as synonym of Genarchopsis. Dwivedi (1965) described the first Indian species from an amphibian host. In 1966, two more new species were added by Gupta and Chakrabarti and Agrawal respectively, of which the former was from a snake. In the same year, Rai and Pande (1966) for the first time pointed out the variability of certain specific characters used by earlier workers and doubted the validity of some species. Anjaneylu (1967) described in detail, the female reproductive system of G. punctati Agarwal, 1966. Subsequently, Kakaji (1969) added two more species from fishes of Lucknow. Rai (1971) briefly discussed the validity of some of the Indian species. Bashirullah and Elahi (1972) added two more species viz. G. ozaki and G. bangladesensis from Channa punctatus at Dacca.

Yamaguti (1958) enlisted the following species under the genus *Genarchopsis*:

G. goppo (Ozaki, 1925) type species; G. gigi Yamaguti, 1919; G. anguillae Yamaguti, 1938; G. mulleri (Levinson, 1818) G.

Iobatum (Srivastava, 1933); G. ovocaudatum (Srivastava, 1933); G. piscicola (Srivastava, 1933); G. singularis (Srivastava, 1933); G. dasus (Gupta, 1951); G. faruquis (Gupta, 1951) and G. indicus (Gupta, 1951).

During recent years following more species have been added:

G. melanostictus Dwivedi, 1965; G. thapari Gupta & Chakrabarti, 1966; G. punctati Agarwal, 1966; G. cuchiai Kakaji, 1969; G. cameroni Kakaji, 1969; G. ozakii Bashirullah and Elahi, 1972; G. bangladesensis Bashirullah and Elahi, 1972; and G. dwivedi n.sp.

Thus, till now the genus Genarchopsis includes 19 species of which 8 have been transferred from other genera. On perusal of literature it is evident that the characters used by earlier workers to differentiate the species are following:

- 1. Size of body
- 2. Ratio of suckers.
- 3. Position of acetabulum
- 4. Presence or absence of oesophagus
- 5. Presence or absence of oesophageal pouch.
- 6. Position of testes.
- 7. Presence or absence of cirrus sac.

- 8. Relative size of the vesicula seminalis and pars prostatica.
- 9. Uncoiled nature of pars prostatica.
- 10. Presence or absence of receptaculum seminis.
- 11. Presence of absence of Mehlis' glands
- 12. Position of Mehlis' glands
- 13. Position and shape of vitelline follicles
- 14. Extracaecal or intercaecal position and extension of uterine coils.
- 15. Presence or absence of a genital papilla
- 16. Position of genital pore
- 17. Presence of a hermaphroditic duct.

A review of the literature and thorough study of the available specimens at the disposal of the writer, studied alive, stained and mounted and serial sections have revealed that the so called above stated diagnostic features stressed in an identification of species utilised by earlier workers are highly variable, particularly in consequence of age and maturity of the specimens and fixation in intergrading series. Further, a true cirrus sac and receptaculum seminalis as described by Gupta and Chakrabarti (1971) and Agarwal (1972), respectively are doubted as these structures are absent in the genus *Genarchopsis*. In the light of above study, an attempt has been made to re—study various species for their validity.

- 1. **G. lobatum** (Srivastava, 1933): Srivastava (1933) described *G. lobatum* from the stomach of *Ophiocephalus striatus* (now known as *Channa striatus*) at Lucknow. Gupta (1951), in his key to the species, differentiated the form from other related species by the shape of vitelline gland and by extension of uterine coils. A careful comparison of the account of *G. lobatum* and *G. goppo* shows that the characters used by srivastava (1933) in distinguishing *G. lobatum* from other known species are more or less similar to *G. goppo* and are in intergrading series. Therefore, the writer regards *G. lobatum* as synonym of *G. goppo*.
- 2. **G. piscicola** (Srivastava, 1933): Srivastava (1933) described the species from the stomach of *Ophiocephalus* punctatus (now regarded as *Channa punctatus*) at Allahabad. It is characterised by larger size, position of acetabulum, ratio of suckers, position of gonads, vitellaria, genital pore and extension of uterus. As these features are variable, the writer regards *G.* piscicola as synonym of *G. goppo*.
- 3. Genarchopsis singularis Srivasvata, 1933: Srivastava (1933) described this species (on a single specimen) from the intestine of a *Ophiocephalus striatus* at Sitapur. However, Chauhan (1953) doubted the validity of the species and pointed out its affinity to *G. goppo*. Subsequently, Rai (1971) considered it a synonym of *G. goppo*. The writer reinforce the doubts of

Chauhan (1953) and agrees with Rai (1971) and regards *G. singularis* as a synonym of *G. goppo.*

- 4. *G. ovocaudatum* (Srivastava, 1933) Manter, 1936: Srivastava (1933) described this species from the intestine of *Ophiocephalus punctatus* at Allahabad. It is characterised by smaller size of the body, position of the acetabulum, course of the intestinal ceaca, caudal position of the testes, smaller size of the shell gland mass, symmetrical position of vitellaria and extension of the uterine coils. Subsequently, Chauhan (1953) doubted the validity of the species and considered it a synonym of *G. piscocola*. Rai (1971) called it a synonym *G. goppo* to which the writer also agrees.
- 5. Genarchopsis dasus (Gupta, 1951): Gupta (1951) described it from the stomach of Ophiocephalus punctatus (Bloch) collected at Saharanpur. One mature and numerous immature specimens were collected but the description is based on the mature specimen. The species is distinguished from O. singularis and O. labatum by the presence of an oesophagus, by absence of oesophageal pouch, non extension of uterine coils behind shell gland mass, relative size of vesicula seminalis and pars prostatica, presence of a hermaphroditic duct and position of the genital pore. As stated earlier, almost all these characters

are variable, depending on the maturity of the specimens and degree of contraction at the time of fixation as the muscular fluke has a mobile preacetabular portion. So creation of a species on such variable feature is uncalled for. Therefore, *G. dasus* (Gupta, 1951) is regarded, as pointed out by Rai (1971), a synonym of *G.goppo* (Tubangui).

Genarchopis indicus (Gupta, 1951): Gupta (1951) created 6. the species (on a number of specimens) from the stomach of O. punctatus (Bloch) examined at Lucknow and Saharanpur. This species is distinguished by position of genital pore, position of vitellaria and relative size and position of the other body organs. On comparison of the account and figure of *G. indicus* one findes a number of discrepencies in the two, the important being the position of genital pore. The writer has stated, "the genital pore lies just behind the oral sucker on the left or the right side of the pharynx" but in the fig, (Fig. 4 page 46) it has been shown to be located in the middle of the oral sucker, definitely ahead of the pharynx. Similarly, the vitelline follicles, as stated by an author consist of two large lobed bodies, which is not so in the figure. Further, the present writer fails to note any appreciable difference in the relative size and position of body organs of G. indicus and G. goppo as they appeared in intergrading series. Thus, all these characters are untenable for specific diagnosis.

Earlier, Chauhan (1953) rightly doubted the validity of *G. indicus* (Gupta, 1951). Therefore, *G. indicus* (Gupta, 1951) is regarded, as pointed out by Rai (1971), a synonym of *G. goppo*.

- 7. **Genarchopsis melanostictus Dwivedi**, **1965**: Dwivedi (1965) described this species from the stomach of a *Bufo melanostictus* at Jabalpur. The account is based on two specimens. The species has been differentiated from others by the position of the genital pore, lobed vitellaria, position and ratio of suckers, well spacious genital atrium, tubular vesicula seminalis, long tubular pars prostatica and semilunar genital pore which are variable features. Therefore, *G. melanostictus* is considered synonym of *G. goppo* and *Bufo melanostictus* is added to the host list of the *G. goppo*.
- 8. *G. dwivedi* n.sp. (included in this thesis): The species in characterised by presence of well developed receptaculum seminis, position of genital pore close behind the pharynx, an oesophageal pouch, symmetrical testes, entire or slightly lobed vetellaria, non extension of uterine coils upto the hind end of the vitellaria and by having Mehlis' gland complex anterior to the ovary.
- 9. *G. thapari* Gupta and Chakrabarti (1966): Gupta *et.al.* (1966) described this species from the intestine of an unidentified

snake at Lucknow. The description is based on four immature specimens. The species is characterised by possession of well developed cirrus pouch, presence of an oesophageal pouch, position of genital pore, uncoiled pars prostatica, absence of genital papilla, intercaecal position of testes, presence of shell gland complex posterior to ovary and the position of testes.

Of these, except for presence of cirrus pouch, almost all features are variable and insignificant for specific identification. Further, the presence or absece of cirrus pouch has a generic status as earlier pointed by Lal (1938). With a view to confirm the presence of cirrus pouch in G. thapari, the writer dissected a number of specimens of two common snakes viz. T. piseator and T. mueosus locally available. Fortunately an immature specimen of Genarchopsis species was collected from the intestine of T. piscator. On subsequent study, it revealed that the specimen resembles G. thapari in almost all the body features except for the absence of a cirrus sac. Consequently, the writer doubts the presence of a cirrus sac in G. thapari. What has been described as cirrus sac in G. thapari is an erroneous observation made by joint authors. The writer is of opinion that type material of G. thapari should be restudied to ascertain the presence of a true cirrus sac and if so, it should be transferred to another genus. Further, the creation of species on characters like

position of shell gland complex, position of testes and uncoiled pars prostatica is not desirable. Therefore, *G. thapari* is tentatively considered synonym of *G. goppo* and *T. piscator* is added to the host list of *G. goppo*.

G. cuchiai Kakaji, 1969: Kakaji (1969) described two specimens) this species from the stomach of Amphipnous cuchia (Ham.) which was collected from District Muzaffarnagar (U.P.). The species has been differentiated by absence of receptaculum seminis, position of genital pore, extension of uterine coils and absence of Mehlis' glands. The uterine coils as stated by Kakaji (1969) are intercaecal and extracaecal in position and are similar to G. goppo. In her diagrames (Fig. 11 on page 74) Kakaji (1969) has definitely drawn an ootype complex surrounded by Mehlis' glands. Further in the writer's opinion the presence or absence of Mehlis' glands is quite unreliable feature for establishing a species as it depends on the maturity and age of the worm. The absence of receptaculum seminis, as stated by Kakaji (1969) is as usual in G. goppo. The position of genital pore is also a variable feature as described by the present writer. Further the measurements of the body organs of G. cuchiai are more or less similar to G. goppo. Therefore, G. cuchiai is regarded as synonym of G. goppo and A. cuchia is added a additional host of G. goppo.

11. *G. cameroni* Kakaji, 1969: Kakaji (1969) described *G. cameroni* (on two specimens) from the intestine of *Mystus seenghala* at Lucknow. The spcies is characterised by extracaecal extension of uterine coils, position of gential pore and testes overlapping intestinal caeca, are more or less similar to some specimens of *G. goppo* in the possession of writer. Further, there is discrepancy in account and figure of *G. cameroni*. Kakaji (1969) has stated the testis as "testis overlapping intestinal ceaca" but in the figure (Fig. 22 page 77) the position of right testis is intercaecal and quite apart from the intestinal caeca.

Therefore, *G. cameroni* is considered synonym of *G. goppo* and *Mystus seenghala* is added as additional host for *G. goppo*.

- 12. *G. ozakii* Basirullah and Elahi, 1972: The species was described by Basirullah <u>et al.</u> (1972), from the intestine of *Channa punctatus* at Dacca. However, the description is based on single specimen. The species is characterised by sucker ratio, position of testes, ovary and vitellaria and smaller oesophageal pouch which as stated earlier, are variable features. Therefore, *G. ozakii* is considered synonym of *G. goppo*.
- 13. *G. bangladesensis* Basirullah and Elahi, 1972: The species has been described on single specimen from the intestine of *Channa punctatus* at Dacca. It is characterised by

ratio of suckers, shape of intestinal caeca and position of testes and vitellaria which are variable features. Therefore, *G. bangladesensis* is regarded as synonym of *G. goppo*.

14 **G. goppo** (Tubangui) Ozaki, 1925 : G. lobatum, G. ovocaudatum, G. piscicola, G. singularis, G. dasus, G. foruquis, G. indica, G. melanostictus, G. thapari, G. cuchiai, G. cameroni, G. ozakii and G. bangladesensis.

Hosts: Channa straiatus, Channa punctatus, Amphipnuous cuchia, Mystus seenghala, Bufo melanostictus, Rana cyanophlyctis and Tropiodonotus piscator.

Family : HETEROPHYIDAE Odhner, 1914

Sub family: HAPLORCHIINAE Looss, 1899

Genus: Haplorchoides Chen, 1949

Haplorchoides seenghali Dayal and Gupta, 1954 (Plate XIV, Fig. 1)

One specimen of this species was collected from the intestine of *Heteropneustes fossilis* (Bl.). A total of 360 specimens of *Heteropneustes fossilis* (Bl.) were examined throughout the year 1993, 1994 and 1995. The fishes were procured from a pond at Jaigaon, in District Bhind (M.P.).

DESCRIPTION

Body very small, oval, with rounded anterior and posterior extremities, measures 0.60×0.24 . Oral sucker subterminal, spherical, 0.06 in diameter. Prepharynx 0.05 in length. Pharynx oval, well developed 0.015×0.011 . Oesophagus 0.012 in length. Intestinal caecae terminating a little anterior to hind end of the body. Acetabulum absent.

Testis single, very large, oval, intercaecal, 0.09 x 0.12. Cirrus

pouch absent. Seminal vesicle bipartite. Genital sac globular situated on left intestinal caecum.

Ovary small, median, pre—testicular, spherical, 0.04 — 0.05. Uterus very extensive occupying the whole postbifurcal body, containing large, yellow, oval filamented eggs occupying entire post—testicular region. Vitelline follicles extending from hind end of ovary to hind end of testis.

DISCUSSION

Chen (1949) established the genus *Haplorchoides* with *H. cahirinus* (Looss, 1896) as its type species.

The question of the validity of the genera *Haplorchis* Looss, 1899; *Monorchotrema* Nishigori, 1924 and *Haplorchoides* Chen, 1949 have been discussed by several authors. Witenberg (1929 and 1930), Srivastava (1935), Chen (1936) and Dawes (1946) considered the synonymy of *Monorchotrema* to *Haplorchis*.

Gohar (1934) and Dayal (1935) considered *Haplorchis* and *Monorchotrema* as distinct genera. Srivastava (1935) splitted the genus *Haplorchis* into two subgenera; *Haplorchis (Monorchotrema)* and *Haplorchis (Haplorchis)*. The subgenus *Haplorchis (Monorchotrema)* is characterized in having prepharynx shorter than oesophagus, testis and vetellaria caudal in position and with a rudimentary acetabulum, while the subgenus *Haplorchis*

(Haplorchis) is characterized in having prepharynx longer than testes and vitellaria more anterior oesophagus, and the acetabulum being absent. Chen (1936) considered the synonymity of the genera Haplorchis Looss, 1899 and Monorchotrema Nishigori, 1924 and considered Haplorchis to be the only valid genus and Monorchotrema to be identical and synonymous to it. In 1949, he differentiated the two genera Haplorchis Looss, 1899 and Haplorchoides n.g. on the basis of relative size of prepharynx and oesophagus, a short prepharynx, long oesophagus, thin—walled vesicula seminalis and more posterior postition of testis and vitellaria characterize Haplorchis while a long prepharynx, short rudimentary oesophagus and more forward position of testis and vitellaria characterize Haplorchoides. Yamaguti (1954) considered Pseudohaplorchis Dayal, 1949 as a synonym of Haplorchoides Chen, 1949.

Gupta (1953), Yamaguti (1958 and 1971) and Agarwal (1964) accepted Chen's (1949) view and considered the genus *Haplorchoides* as distinct from *Haplorchis* whereas Chatterji (1953 and 1956) and Baugh (1963) considered *Haplorchoides* as a synonym of *Haplorchis*. Later Pearson (1964) accepted this genus and placed it under the family Heterophyidae on the basis of the position and shape of excretory bladder. Rai and Pande (1967) agreed with Pearson (1964) and placed it in the sub—

family Haplorchiinae Looss, 1899 on the basis of the presence of armed acetabulum embedded inside the ventrogenital sac and saccular and post—testicular excretory bladder. In the present study, the latter arrangement has been accepted.

Haplorchoides seenghali has been described by Dayal and Gupta (1954) from the intestine of Mystus seenghala. Gupta (1955) gave complete description of the species but described it as a new species.

The present specimens resemble type specimen except for smaller size of body, in principal body measurements and very large size of testis, which may be regarded as variable characters. So the specimen described here is considered as *Haplorchoides* seenghali Dayal and Gupta, 1954.

> Heteropneustes fossilis (Bl.) Host

Location Intestine

Jaigaon, Distt. Bhind (M.P.) Locality

(104)

Family: HETEROPHYIDAE Odhner, 1914

Sub family: HAPLORCHIINAE Looss, 1899

Genus: Haplorchoides Chen, 1949

- 1. Haplorchoides attenuatus (Srivastava, 1935)
 (Syn. Haplorchis silundi Srivastava, 1935;
 Haplorchoides seenghali Gupta, 1953;
 H. macronis Agarwal, 1964;
 Monorchotrema taakree Dayal, 1935;
- 2. Haplorchoides piscicola Srivastava 1935; (Syn. Haplorchis gangeticum Srivastava 1935;

H. ritai Gupta 1953;

H. brahamputrensis Gupta, 1953;

H. gomtiensis Gupta, 1953

H. parini Chatterji, 1956

Pseudohaplorchis macrones Dayal, 1949

ON THE VALIDITY OF HAPLORCHINE FLUKES FROM INDIAN SILUROID FISHES

(Plate XV, Figs. 1—9; Plate XVI, Figs. 10—14)

INTRODUCTION

The small—sized haplorchine flukes, with comparatively feeble suckers, a complex ventro genital sinus and a single testis, occur as intestinal parasites in fishes, birds and mammals. These

have been assinged to a number of genera including Haptorchis Looss, 1899; Monorchotrema Nishigori, 1924; Kasr Khalil, 1932; Pseudohaplorchis Dayal, 1949; Haplorchoides Chen, 1949 and Euhaplorchis Martin, 1950. The species from siluroid fishes in Indian region are: Haplorchis attenuatus Srivastava, 1935; H. piscicola Srivastava, 1935; H. gangeticum Srivastava, 1935; and H. silundi Srivastava, 1935 — from Allahabad; Monorchotrema taakree Dayal, 1935 and Pseudohaplorchis macrones Dayal 1949 from Lucknow; Haplorchoides gomticusis Gupta, 1953; H. ritai Gupta, 1953; H. brahamputrensis Gupta, 1953 and H. seenghali Gupta, 1953; the first two from Lucknow and the last two from Assam; Haplorchis parini Chatterji, 1956 from Allahabad and Haplorchoides macronis Agrawal, 1964 from Lucknow. (P. macrones was exlcuded by Chatterji (1956) from his comparative table related to Haplorchis species parasitic in fishes).

There have been conflicting views on the question of the validity of *Monorchotrema*, *Pseudohaplorchis* and Haplorchoides. Yamaguti (1954) considered *Pseudohaplorchis* as a synonym of *Haplorchoides* (Gupta, 1953) and retaining both *Pseudohaplorchis* and *Haplorchoides* with which *Monorchotrema* was held to be indentical, included all the above mentioned nine species under *Haplorchoides*. Chatterji (1956), believing *Monorchotrema* as identical to *Haplorchis*, suppressed *Haplorchoides* as a synonym

of *Haplorchis* in which all the species were included. Yamaguti (1958), synonymising *Monorchotrema* and *Pseudohaplorchis* with *Haplorchoides*, listed all the species from fishes under it. Agrawal (1964), following Gupta, has retained *Pseudohaplorchis* and considered *Haplorchis* distinct from *Haplorchoides* to which all the species occuring in fish have been assigned by her.

A perusal of the description of these species clearly reveals that the validity of the various species has not been correctly assessed. The prevailing chaos and confusion around Haplorchis and Haplorchoides has, however, been cleared by Pearson (1964). From a study of a new species of Haplorchoides, Pearson believed that this genus contains the species occuring in fish. Haplorchoides, characterised by a saccular and post testicular excretory bladder, possesses an armed and modified acetabulum lying obliquely inside the ventrogenital sac. The author follows Pearson (1964) in separating the species parasitic in fishes under Haplorchoides as Person's plan conforms fully to this author's conclusions reached from a study of the extensive material collected from the five siluroid fishes. The author fully agrees with the view of Jain (1967) that Chain's conclusion regarding differentiation of the various species of the genus Haplorchis should not be taken into account which is based only on the armature of gonotyle.

Numerous specimens of *Mystus seenghala, Eutropiichthys* vacha, *Mystus vittatus, Wallago attu* and *Clupisoma garua* from Chambal region were available for examination. The first two fishes invariably revealed a greater incidence. The collection was studied alive, from stained permanent mounts and in sections. The parasite identified as *H. piscicola* did not appear to be significantly pathogenic.

The ventro—genital complex, correctly emphasized by Pearson as the sole morphological feature, was totally ignored by Srivastava, Gupta, Chatterji and Agrawal who have, on the other hand, relied on the shape of the body, the general topography and position of the organs, the comparative size of the prepharynx and oesophagus, the relative position of the genital pore, the size and extent of the seminal vesicle, and the extent and distribution of the vitellaria — characters showing variations from age and fixation. Besides, the excretory bladder described invariably as Y-shaped, is really saccular and the eggs in some mentioned as macrones have been species such P. as unoperculated. Particulars about the number of the rodlets, except for M. taakree in which 47 spines are given and P. macrones where 35 - 38 spines have been described, are also lacking.

A careful study of the ventro — genital sinus reveals that the embedded accetabulum carries an armature of weakly chitinised fret—saw—shaped rodlets, either 42—48 or 35—40 in number. Apart from this character, an extreme degree of variability in the characters stressed by Srivastava, Dayal, Gupta, Chatterji and Agrawal in distinguishing their species is observed in the developing and fully mature specimens.

OBSERVATIONS AND DISCUSSION

These small distomes, with spined body—wall, whitish to yellow in colour and with a comparatively more active preacetabular region, were in two distinct forms — elongated or spindle—shaped and with a somewhat ovoid or spherical outline. The body movement, in the fully mature specimens, was less marked. Microscopic examination revealed slight differences in regard to the character and distribution of the vitellaria, the number of rodlets and in the host species.

A. From Mystus seenghala and Wallago attu

The elongated or spindle—shaped specimens (Fig. 1, 2 and 3) with a somewhat attenuated anterior region, measured 0.80 - 1.15 mm. in length and 0.2 - 0.04 mm in maximum breadth which in the mature specimens lay in the testicular region. The subterminal oral sucker was 0.038 - 0.064 mm in diameter. The

prepharynx measured 0.17 - 0.25 mm. in length. The pharynx lying at about the middle of the prebifurcal region, measured 0.04 -0.06 mm x 0.03 - 0.04 mm. in size. In the younger specimens and those fixed with the forebody fully extended, the total length of the prepharynx and oesophagus varied considerably. The genital pore, situated immediately near the intestinal bifurcation, was somewhat laterally displaced lying internally to the caecum (Fig. 1), overlapping it or lateral to it (Fig. 3). Through a duct, it communicates upto the ventro-genitel sinus containing the embeded and armed acetabulum. The rounded and thick walled acetabulum carried a circlet of 42 — 48 fret—saw—shaped rodlets (in a single row) (Fig. 4). The terminal excretory pore opened into the sac-shaped excretory bladder which, behind its anterior margin, received the two main collecting canals (Fig. 14). The intestinal caeca, extending behind the middle of the body, terminates a little behind the testis. The testis, lying in the posterior half of the body, was intercaecal, nearly spherical in outline, with smooth margin, and occasionally displaced slightly laterally, measured 0.25 - 0.36 mm. x 0.21 - 0.3 mm. in size. The bilobed seminal vesicle, lying obliquely and antero-laterally to the ovary, had the anterior and posterior lobes of 0.06-0.15mm. \times 0.061 — 0.15 mm. and 0.032 — 0.15 mm. \times 0.03 — 0.09 mm. size respectively — the size of the lobes depending on the

amount of the sperm mass. The seminal vesicle, through a small eiaculatory duct, terminally opened jointly with the metraterm into the ventro—genital complex (Fig. 6). The pretesticular ovary, of rounded shape and with smooth margin, was median in position and, usually lying midway between the intestinal bifurcation and anterior margin of the testis, measured 0.1 - 0.15mm. in diameter. The nearly rounded receptaculum seminis, of 0.1 - 0.15 mm x 0.1 - 0.16 mm. in size was situated latero posteriorly to the ovary — the Mehlis' gland lying between it and the ovary. The uterus, in its descending and ascending occupied the available spece between the Mehlis' gland and the posterior extremity. The pre-ovarian uterine coils continued into a distinct metraterm which terminally opened, alongwith the ejaculatory duct, into the posterior border of the genital sinus. The vitelline follicles were post—ovarian, mostly lateral and extended from near the Mehlis' gland complex to a little distance in front of the posterior extremity — a few follicles in the pre and post—testicular areas passing inwards to meet mesially. Eggs were light yellowish in colour, operculated, fully embryonated and $0.024-0.03 \text{ mm} \times 0.013 - 0.016 \text{ mm}$. in the size (Fig. 8).

These specimens, on account of their general characters, totally agreed with *H. attenuatus* orginally described from *M. seenghala*. This species has been differentiated by its author from

the genotype, H. cahirinus, on account of the larger number of spines (H. cahirinus has been reported to possess five spines only) but the number of rodlets in the original account of H. attenuatus has not been indicated. My specimens, taking into consideration the different variations, were also found to resemble fully such other species as H. silundi from Silundia gangetica; Monorchotrema taakree from Pseudotropius taakree; and H. macronis from M. seenghala in all of which except for M. taakree, where the number of rodlets has been described as 47, the total numbers have not been given. Accordingly, the description of *H. attenuatus* has to be emended to incorporate the number of the rodlets and the extreme variations observed by me. All these species are, therefore, suppressed as synonyms of *H. attenuatus* for which the above account "with 42—48 rodlets" would provide the diagnosis.

B. From E. vacha M. vittatus and C. garua.

The ovoidal, elliptical or spherical forms measure 0.8-2.3 mm. in length and 0.30-0.58 mm. in maximum breadth (Figs. 10, 11, 12 and 13). The subterminal oral sucker was 0.06-0.1 mm. in diameter. The prepharynx was of 0.15-0.22 mm. in length. The pharynx measured 0.04-0.06 mm. x 0.03-0.04 mm. in size. The oesophagus, 0.05-0.07 mm. in length,

showed variation due to fixation. The intestinal caeca extended posteriorly upto the testis. The laterally placed genital pore, lying intestinal bifurcation revealed viable in the region of the positions — lying medially or laterally behind the bifurcation or on level with it. The acetabulum, embedded inside the ventro genital sinus, carried a circlet of weakly chitinised 35 - 40 fretsaw-shaped rodlets (Fig. 5). The median testis was usually spherical and 0.1 - 0.22 mm. x 0.1 - 0.19 mm. in size. The characteristically bilobed seminal vesicle had the anterior lobe of 0.06 - 0.09 mm. $\times 0.06 - 0.08$ mm. and the posterior of 0.02 - 0.03 mm. x 0.015 - 0.02 mm. size. The ejaculatory duct opened, jointly with the metraterm inside the ventro-genital sinus. The pre-stesticular and rounded ovary was median and measured 0.08 - 0.15mm. x 0.07 - 0.14 mm. in size. The complex lay between the ovary and the Mehlis' gland receptaculum seminis, which is of 0.08 - 0.1 mm. x 0.07 -0.09 mm. size, was significantly reduced in some of specimens or was even absent in several others (Fig. 10.). The uterus in its descending and ascending coils, occupied the available space between the Mehlis' gland and posterior end of the body. In a number of specimens, some area in the posterior body regions appeared free from eggs. The ascending uterine limb, on its way to the genital sinus, passed into the metraterm (Fig. 7). The vitelline follicles, lying lateral to the gonads, extended from the Mehlis' gland to a little distance behind the intestinal caeca — a few follicles in the post testicular space passing inwards. The eggs were of light yellow colour, operculated, fully embryonated, and measured 0.02 — 0.04 mm. x 0.012 — 0.017 mm. in size (Fig. 9).

These specimens conformed fully to the description of H. piscicola in which the description is likewise silent regarding the number of rodlets. The number of the rodlets, given for H. macrones, is 35 which can be included within the range encountered by me. The specific description for H. piscicola requires to be emended in order to include the different variations encountered and "35 — 40 rodlets." H. gangeticum, H. macrones, H. parini, H. gometiensis, H. ritai and H. brahamputrensis are presently suppressed as its synonyms. Haplorchoides is thus represented in my collection of fresh water fishes by only the two species, H. attenuatus and H. piscicola. Future work on life history stages of these and allied systematic units, solely based on adult characters which are not infrequently and inadequately described, would provide correct clues for determining their true taxonomic status.

ABSTRACT

From a study of numerous specimens of haplorchine flukes studied from five species of siluroid fishes, obtained from two different localities in Chambal region, the twelve species hitherto described under *Haplorchis, Monorchotrema, Pseudohaplorchis* and *Haplorchoides* have been found to be based on extremely variable characters. The only criterion of taxonomic importance in addition to the body shape is the armature of rodlets carried by the acetabulum embedded in the ventro—genital complex. Accordinly, the valid species are *Haplorchoides attenuatus* (Syn. *H. silundi, Monarchotrema taakree, Haplorchoides macronis*) and *Haplorchoides piscicola* (Syn. *Pseudohaplorchis macrones, Haplorchis gangeticum, Haplorchoides parini, H. gomtiensis, H. ritai* and *H. brahamputrensis*). *Mystus vittatus,* and *Clupisoma garua* are added to the known hosts range.

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Family : MONORCHIIDAE Odhner, 1911

Sub family: PROCTOTREMATINAE Odhner, 1911,

emend. Yamaguti, 1934.

Genus: Asymphylodora Looss, 1899

Asymphylodora chambali n.sp. (Plate XVII, Fig. 1)

During the course of examination of a collection of digenetic trematodes of fresh water fishes of Chambal region, one new species of the genus *Asymphylodora* was collected from the intestine of *Puntius sarana*, it was collected from Chambal river in the district Morena. It is named after the name of river Chambal. It is described here. All measurement are in millimeters.

DESCRIPTION

The worms are very small with an elongated and flattened body, 0.79-1.28 long and 0.28-0.49 in maximum breadth between acetabulum and ovary (average length/breadth ratio = 2.5/1). The integument of the anterior end is beset with a few rows of very minute spines. A row of very minute spines is also present on the oral sucker. Deeply staining unicellular glands are

present in the anterior region of the body. The details of measurement taken from the type specimen, 1.12 long and 0.48 in maximum breadth, are given below:

Oral sucker subterminal, measures 0.14×0.16 , and leads directly into a well developed muscular pharynx measuring 0.09×0.016 . Oesophagus 0.12 long and bifurcating into two simple intestinal caeca extending posteriorly upto the level of middle of the testis (i.e. upto 80% of the body length from the anterior end). Acetabulum measures 0.16×0.18 , lies 0.27 from anterior end (i.e. near 25% of body length from the anterior end), and covers the point of intestinal bifurcation. Excretory bladder tubular. Excretory pore terminal at the posterior end.

Testis single, oval, massive, post—ovarian, measures 0.31 x 0.16, and lies near the posterior end of body. Cirrus sac prominent and retort—shaped, 0.28 x 0.10, broadest at its posterior end, situated obliquely on the left side of acetabulum and extending posteriorly much beyond it and crossing the left caecum anteriorly. Vesicula seminalis voluminous, non—bipartite and occupying almost the whole of the cirrus. Pars prostatica and ductus ejaculatorious very short. Cirrus 0.105 long, well developed, curved and unarmed. Genital pore sub—marginal, extracaecal and at the level of middle of acetabulum between left intestinal caecum and body wall.

Ovary 0.10 x 0.15, median, post—equatorial, immediately pre—testicular and in contact with the anterior border of the testis. Mehlis' gland complex anterolateral to ovary. Receptaculum seminis present. Vitellaria lateral, mostly extracaecal and composed of few follicular acini extending from the level of middle to posterior border of acetabulum to the caecal ends (about middle of testis). Uterus occupies the entire space between acctabulum and the gonads and extend into the post—testicular zone upto the posterior end of the body. Metraterm runs parallel to the cirrus sac and opens into genital atrium. Eggs measure 0.019 x 0.009 and each one contains a developing embryo.

Host : Puntius sarana (Hamilton)

Location: Intestine

Locality: Chambal river, District Morena (M.P.)

DISCUSSION

Yamaguti (1958) has listed sixteen species of the genus Asymphylodora. Of these, a number of species have been regarded as synonyms by Witenberg and Eckmann (1934). So far as the author is aware, only three species of Asymphylodora namely, A. indica H.D. Srivastava, 1936, A. kedarai N.N. Srivastava, 1961 and A. ritai Gupta and Agrawal, 1967 have been reported from India. Rai (1971) collected and studied a number of

specimens of Asymphylodora tincae (Modeer, 1790) from Puntius sarana, Puntius sophore and Mystus vittatus at Gorakhpur (U.P.). He found that specimens of A. tincae showed a side range of variations in the disposition of organs and A. tincae, A. kedarai and A. ritai came within the range of those variations. Rai, therefore, conduded that A. indica, A. kedarai and A. ritai were identical to A. tincae, the type species of the genus Asymphylodora. It is difficult to agree with Rai (1971) if a comparison is made of his description of A. tincae with those of A. indica, A. kedarai and A. ritai.

Asymphylodora tincae Rai, 1971: Oral sucker larger than acetabulum; prepharynx present; intestinal caeca upto ovary or anterior level of testis; cirrus unarmed; seminal vesicle bipartite; vitellaria from middle of acetabulum to ovarian zone; eggs with a spine — like process at the non—operculate end, excretory bladder tubular.

Asymphylodora indica Srivastava, 1936: Large size; oral sucker larger than acetabulum; long oesophagus; more anterior extent of vitellaria; cirrus sac does not extend beyond acetabulum; eggs unfilmented and without spine; Y—shaped excretory bladder.

Asymphylodora kedarai Srivastava, 1951: Oral sucker

smaller than acetabulum; cirrus and metraterm unarmed; no prepharynx; very short oesophagus; cirrus sac extends beyond acetabulum; non operculate and non spiny eggs; caeca up to middle of ovary; seminal vesicle bipartite; vitellaria from middle of acetabulum to caecal ends; excretory bladder tubular.

A. ritai Gupta and Agarwal, 1967: Oral sucker larger than acetabulum; excretory bladder tubular.

It would appear that Rai's specimens are comparable with A. ritai because of the possession of an oral sucker larger than acetabulum and a tubular excretory bladder. Rai's suggestion that A. indica, A. kedarai and A. ritai are identical to A. tincae does not seem to be tenable.

The new form described here resumbles *A. kedarai* in the possession of an unarmed cirrus and metraterm, an oral sucker smaller than acetabulum, over lapping of bifurca by acetabulum and in the position of the genital pore. But the following differences between the new form and *A. kedarai* cannot be ignored —

	A. kedarai	A. Chambali n.sp.
Length/Breadth ratio	1.7/1	2.5/1
Posterior extent of intestinal caeca	Upto middle of ovary	Upto middle of testis
Ovary	at the junction of 3rd and 4th quarters of body	at 60% of body length from the anterior end
Vetellaria	Up to ovarian zone	Upto middle of testis.
Seminal Vesicle	Bipartite	Not bipartite

On account of these differences, the form described here in considered to be a new species and is named *Asymphylodora* chambali after the name of the Chambal river.

Family: OPECOELIDAE Ozaki, 1925

Sub Family: PLAGIOPORINAE Manter, 1947

Genus: Neopodocotyle Dayal, 1950

Neopodocotyle dholpuri n.sp. (Plate XVIII, Figs. 1 — 3)

Numerous specimens were recovered from the intestine of a fresh water fish, *Ambasis nama* (Hamilton) collected from river Chambal in the district Dholpur (Rajasthan). On detailed study these were found new to science. They are named as *Neopodocotyle dholpuri* n.sp. after the name of district Dholpur from where the host was procured.

DESCRIPTION

Body elongated, aspinose with rounded extremities, 3.21 to 4.68 mm. long by 0.86 to 1.32 mm wide between ovary and ventral sucker. Oral sucker spherical, subterminal, 0.35 to 0.45 mm. long and 0.34 to 0.47 mm. wide. Ventral sucker spherical, smaller, equal or larger than oral sucker, 0.38 to 0.48 mm. long and 0.30 to 0.50 mm. wide at 0.68 to 0.89 mm. from anterior

extremity. Prepharynx absent; pharynx muscular, oval 0.15 to 0.26 mm. long and 0.14 to 0.24 mm. wide, esophagus tubular, coiled, 0.13 to 0.18 mm. long bifurcating into slender intestinal caeca, extending upto posterior end of body.

Excretory bladder tubular extending to level of posterior testis; excretory pore terminal.

Genital pore slightly to left side of pharynx at 0.54 to 0.76 mm. from anterior extremity.

Testes oval or spherical, equal or subequal, diagonal and post equatorial. Anterior testis, 0.32 to 0.45 mm. long and 0.28 to 0.46 mm. wide at 1.88 to 2.94 mm. from anterior extremity. Posterior testis equal, smaller or larger than anterior testis, 0.35 to 0.54 mm. long and 0.27 to 0.46 mm. wide. Cirrus pouch claviform extending from genital pore to middle of ventral sucker, 0.46 to 0.66 mm. long and 0.12 to 0.18 mm wide. Veiscula seminalis tubular, convoluted, occupying posterior part of cirrus pouch, 0.44 to 0.65 mm. long by 0.05 to 0.07 mm wide; pars prostatica globular, 0.13 to 0.18 mm. long by 0.04 to 0.06 mm. wide; ejaculatory duct tubular, 0.13 to 0.17 mm. long; cirrus muscular with straiations at its anterior end. Ejaculatory duct and pars prostatica surrounded by large number of prostate gland cells.

Ovary oval or spherical, post—acetabular, pre—equatorial, 0.25 to 0.34 mm. long by 0.24 to 0.38 mm. wide at 1.04 to 1.38 mm. from anterior extremity. Receptaculun sminis pear shaped, posterior to ovary, 0.24 to 0.35 m. long by 0.08 to 0.14 mm. wide. Vitellaria follicular extending from middle region of ventral sucker to hind end of body mainly along outer margin of caeca but extending into intercecal space and back of posterior testis. Uterine coils occupying space between anterior testis and genital pore. Metraterm muscular, lying on left side of ventral sucker. Eggs oval with thick brown shell, 0.074 to 0.092 mm. long by 0.053 to 0.060 mm. wide.

Host : Ambasis nama (Hamilton)

Location : Intestine

Locality: Chambal river, District Dholpur.

DISCUSSION

Dayal (1950) erected the genus *Neopodoctyle* for *N. indica* as its type species in having ventral sucker near oral sucker and in the extension of uterus from anterior end of testes upto ventral sucker under the family Allocreadiidae Looss, 1903. Yamaguti (1958) has reduced this genus to the rank of subgenus under *Podocotyl* (Duj., 1845) and placed it under the sub family *Allocreadiinae* Looss, 1920 of the family *Allocreadiidae*. He

divided the genus into three subgenera namely *Podocotyle*, *Podocotyloides* Yamaguti, 1934 and *Neopodocotyle*. He distinguished *Neopodocotyle* from *Podocotyle* and *Podocotyloides* in having ovary separated from the anterior testis by uterus. Further he distinguished *Podocotyloides* from *Podocotyle* in having acetabulum pedunculate, surmounted puckered margin of peduncle and in having excretory vesicle long and reaching beyond ovary. Skrjabin, Petrow and Koval (1958) recognised *Podocotyloides* as a distinct genus.

Mehra (1966) regarded *Podocotyle* and *Podocotyloides* and *Neopodocotyle* as distinct genera under the sub family *Plagioporinae* Manter, 1947 of the family Opecoelidae Ozaki, 1925, He maintains *Neopodocotyle* as a distinct genus as it does not possess acetabulum with short peduncle and the genital pore lies to the left of pharynx whereas in *Podocotyle* it lies slightly to the left of intestinal bifurcation or at level of oesophagus. He also recognises *Podocotyloides* as a distinct genus as it has much longer excretory vesicle which extends almost to acetabulum, beyond the anterior limit of *vitellaria* in having comma shaped metraterm provided with manchette and in the extension of cirrus sac a little farther than the posterior limit of the anterior third of the body and in having eggs with a knob like protuberance at the antiopercular pole. The author is in agreement with Mehra

(1966) in considering the genera *Podocotyloides* and *Neopodocotyle* distinct from the genus *Podocotyle* as the characters suggested by him for separating the various genera are based on valid grounds. The genus *Neopodocotyle* is distinct from *Podocotyle* as the position of genital pore lies to left side of pharynx, the pars prostatica is distinct and uterus extending to anterior testis are the distinctive features.

Due to the position of genital pore on the left side of pharynx and the uterus extending to anterior testis, the present form is referred to the genus *Neopodocotyle* Dayal, 1950.

The new form differs from *N. indica* in the extension of cirrus pouch up to middle of ventral sucker, in having a convoluted vesicula seminalis, in the possession of a distinct pars prostatica and in having striations at the anterior end of the cirrus.

The new form differs from another new species of the genus *Neopodocotyle morenai* (described in this thesis) in following characters (i) *N. morenai* n.sp. has the two testes very close to one another, and its cirrus sac extends over the antero—lateral aspect of the right side of ventral sucker and sometimes reaches anteriorly, crosses the left intestinal caeca.

Accordingly it is regarded as a new species with the specific name *N. dholpuri* n.sp.

KEY TO THE SPECIES OF THE GENUS NEOPODOCOTYLE DAYAL, 1950

- 1. Cirrus pouch extends upto middle part of the ventral sucker and pars prostatica present *N. dholpuri* n.sp.
- 2. Cirrus pouch extending upto hind end of the ventral sucker and pars prostatica absent *N. indica* Dayal, 1950.
- 3. Cirrus pouch (Sac) extends anteriorly, crosses the anterior part of right intestinal caec *N. morenai* n.sp.

Family : OPECOELIDAE Ozaki, 1925

Sub family: PLAZIOPORINAE Manter, 1947

Genus: Neopodocotyle Dayal, 1950

Neopodoctotyle morenai n.sp. (Plate XIX, Fig. 1)

Five specimens of a treamatode were collected from the intestine of the siluroid fish, *Rita rita* (Hamilton), obtained from the river Chambal in District Morena. Only two of the three fishes examined were found infected with these trematodes. On examination, the specimens were found to be a new species of the genus *Neopodocotyle* Dayal, 1950.

The description given below is based on the study of stained, permanent whole mounts of three specimens. All measurements are given in millimetres.

DESCRIPTION

The worms are small and elongated with rounded anterior and posterior ends. The body is aspinose and measure 4.30 – 4.76 in length and 1.12 – 1.44 in maximum breadth, which

is in the region of ovary.

The oral sucker is circular, subterminal and 0.32-0.36 x 0.39-0.45 in size. The ventral sucker measures 0.38-0.47 x 0.47-0.50. It is slightly larger than the oral sucker and situated at a distance of 0.9-1.12 from the anterior end of the body. The average ratio between the oral and the ventral sucker is 1:1.28.

The mouth is situated in the anterior part of the oral sucker. It is followed by a prominent muscular pharynx, lying contiguous with the oral sucker and measuring 0.19 — 0.21 x 0.23 — 0.25. The pharynx leads into a narrow oesophagus, 0.25 long. The intestinal caeca extend almost up to the hind end of the body and are not clearly visible due to overlapping of the vitelline follicles.

The excretory pore lies at the posterior end of the body. It leads into a long tubular excretory bladder, which extends beyond the anterior testis.

The genital pore is very prominent and is surrounded by a circlet of spines. It lies on the leftside of the oesophagus immediately in front of the point of origin of the intestinal caeca.

The testes are roughly oval and tandam. They lie 0.21 — 0.28 apart, in the posterior half of the body. The anterior

(129)

testis measures $0.43 - 0.50 \times 0.47$ and lies 2.4 - 2.6 mm. behind the anterior end of the body. The posterior testis is slightly larger than the anterior and measures $0.54 - 0.60 \times 0.47 - 0.54$.

The cirrus sac has a transparent membranous wall and is dorsal to and on the right side of the ventral sucker. It is 0.5 — 0.6 mm. long by 0.47 — 0.54 mm. broad. It extends anteriorly from the level of the posterior margin of the ventral sucker and then runs obliquely to cross the left intestinal caecum to open at the genital pore. Sometimes the cirrus sac extends over the antero—lateral aspect of the right side of the ventral sucker (See figure). A distinct pars prostatica appears to be absent. The broader posterior half of the cirrus sac is occupied by a coiled vesicula seminalis and this is followed by a long ejaculatory duct. The prostate gland cells surround the ejaculatory duct and the anterior lobes of vesicula seminalis.

The ovary is roughly spherical and is 0.32-0.36 mm. $\times 0.31-0.32$ mm. in size. It lies at a distance of 1.41-1.65 mm. (about 1/3 of the length) from the anterior end of the body. A large sac—like receptaculum seminis, measuring 0.31-0.45 $\times 0.13-0.18$, extends behind the ovary and is seen to occur either on the right or left side of the median line.

The viteline glands consist of large follicles extending from the level of the middle region of the ventral sucker to the posterior end of the body. The follicles are mainly circumcaecal but extend into the intercaecal space between the two testes and become confluent in the region behind the posterior testis.

The uterus occupies the space between the anterior testis and the ventral sucker. The terminal part of the uterus runs along the outer border of the cirrus sac.

The eggs are oval, measuring $0.073 - 0.085 \times 0.036 - 0.48$, and are provided with a thin yellowish — brown shell.

Host

Rita rita (Hamilton)

Location

: Intestine

Locality

: Chambal river, District Morena (M.P.)

DISCUSSION

The genus *Neopodocotyle* was created by Dayal (1950) for the reception of the trematode *Neopodocotyle indica* collected from the intestine of *Caillichrous bimaculatus* at Lucknow. Yamaguti (1958) has regarded *Neopodocotyle* as a subgenus of the genus *Podocotyle*, which has been suitably revised by Park (1937), and has provided a key to the identification of its three subgenera namely, *Podocotyle*, *Podocotyloids* and *Neopodocotyle*. *Podocotyle* and *Podocotyloids* are marked out by having the

uterus extending between the ovary and the ventral sucker. Podocotyloids is further characterized by the possession of a pedunculated acetabulum surmounted by the puckered margin of the peduncle and a long excretory vesicle reaching beyond. ovary. In Neopodocotyle, the uterus extends between the anterior testis and acetabulum.

The geographical distribution of the above forms is also peculiar. Species of *Podocotyle* have been reported mostly from marine fishes from Canada, Florida, California, Japan, the English Channel, White sea, Galapagos islands, etc. Podocotyloids petallophallus (the only species histherto known) has been reported by Yamaguti (1934) from Japan. Neopodocotyle, with its single species N. indica so far recorded is known from India only. The third species of this genus is reported and described in this thesis as N. dholpuri n.sp. It is difficult to comprehend why the three subgenera of a cosmopolitan form like Podocotyle should have such strictly limited distribution. Many forms of the subfamily Allocreadiinae, for example, Plagioporus and Podocotyle, show minor differences in characters, but they have been assigned distinct generic status. On these grounds, it seem reasonable to regard Neopodocotyle as a valid genus until further investigations and experimental evidence prove to the contrary.

The new form differs from *N. dholpuri* n.sp. (described in previous pages) in having two testes apart, at a distance from one another. In *N. dholpuri* two testes are very close to one another.

The new form described here differs from Neopodocotyle indica in the following respects:

- 1. The ventral sucker is larger than the oral sucker and is situated at about 20% of the body length from the anterior end. The average ratio between the oral and ventral sucker is 1:1.28. In *N. indica,* the ventral sucker is nearly equal to the oral sucker and it lies at about 15% of the body length from the anterior end. The ratio between the oral and ventral sucker is 1:1.01.
- 2. Testes have a relatively more posterior position. The anterior testis lies at about 60% of the body length from the anterior end. In *N. indica*, the anterior testis is immediately post—equatorial and the posterior testis is relatively farther from the posterior end than in the form under discussion.
- 3. The genital pore is surrounded by a circlet of spines.
- 4. The metraterm and the cirrus sac are both on the same (right) side of the ventral sucker. In *N. indica,* the the

metraterm is on the left and the cirrus sac on the right side of the ventral sucker.

Therefore, the form described here in regarded as new and it is proposed to name it as *Neopodocotyle morenai* after the name of locality.

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Family : PARAMPHISTOMIDAE Fischoeder, 1901

Sub family: CABALLEROIINAE Yamaguti, 1971

Genus: Caballeroia Thaper, 1960

Caballeroia mihonai n.sp. (Plate XX, Fig. 1)

During the course of study of trematode parasites of fishes of Chambal river and other ponds etc. in the Chambal region, the author came across with eleven specimens collected from the intestine a fresh water fish, *Macrognathus aculeatus* (Bloch), procured from a catch in Chambal river in the village Mihona, in the district Bhind (M.P.). These specimens on detailed study were found to constitute a new species belonging to the genus *Caballeroia* Thaper, 1960. It is designated as *C. mihonai* n.sp. after the name of locality, village Mihona.

The new species is described herewith alongwith a review of the status of the genus and its existing species, viz. *C. indica* Thaper, 1960 and *C. bhavani* (Achan, 1956) Devraj, 1972. The generic and sub family diagnosis have also been modified in the light of present observations.

DESCRIPTION

Body elongate, attenuated anteriorly and rounded posteriorly, measures $4.32-4.97 \times 1.148-1.248$ mm. in maximum width in post equatorial region. Anterior end bears small conical papillae arranged in 10-12 circular rows upto end of oral pouch leaving rest of the body smooth. Oral sucker subterminal, 0.168-0.25 mm. in diameter, with long claviform paired oral pouch on either side of the oesophagus, 0.25 mm. in length. Pharynx is absent. Mouth directly leads to long, narrow oesophagus which broadens into muscular oesophageal bulb before it bifurcates into two caeca. Caeca are sinuous and terminate some distance anterior to acetabulum, at times asymmetrical. Acetabulum ventroterminal, smaller than posterior body width 0.45-0.53 mm. in diameter.

Testes two, pre—equatorial, just below the caecal bifurcation, intercaecal, symmetrical or oblique, entire with lateral sides almost touching or overreaching the caeca, measure 0.518 — 0.602 mm x 0.435 — 0.518 mm. and 0.588 — 0.700 mm x 0.0350 — 0.416 mm. respectively. Elongated, pear shaped cirrus sac is placed just below the caecal bufurcation, measures 0.160 — 0.350 mm. x 0.154 — 0.182 mm. It is thick walled and encloses coiled vesicula seminalis interna and cylindrical

cirrus. Vesicula seminalis externa is long and coiled. Genital pore is bifurcal or just prebifurcal, slightly towards right side and is quarded by a genital sucker.

Ovary is small, round placed in median field in between the caecal ends and acetabulum near posterior extremity, measures 0.120 — 0.140 mm. in diameter. Shell gland mass is just posterior to ovary. Receptaculum seminis and Laurer's canal are present. Vitelline follicles are internally placed in extra caecal fields, at times over lapping the caeca and extend from some distance anterior to ovary becoming U—shaped in posterior zone (almost contiguous). Vitelline ducts of the two sides meet to form a common vitelline reservoir from which a common vitelline duct joins the ootype. Uterus extensive, intercaecal, the loops passing through intertesticular space in specimens where two testes do not overlap. Eggs are embryonate, cylindrical, 0.084 — 0.168 mm x 0.042 — 0.070 mm. Uterine eggs are smaller.

Excretory bladder saccular, just anterior to acetabulum. Two excretory canals start from either side of the bladder and reach upto the oral sucker. Excretory pore is dorso—subterminal. One pair of lymphatic vessels could be observed in my specimens.

Host : Macrognathus aculeatus (Bloch)

Location: Intestine

Locality: Chambal river, District Bhind (M.P.)

DISCUSSION

Thapar (1960) described the genus Caballeroia to accomodate his new species C. indica collected from Cirrhina fuleagel caught at Tungbhadra Dam. He did not assign his new genus to any of the sub families of the family Paramphistomidae. Mukherjee and Chauhan (1967) though commented about non-assignment of this genus to any of the existing sub families but prefered to maintain status quo. Yamaguti (1971) erected a new sub family for this genus. Devraj (1972) unaware of Caballeroiinae. Yamaguti's allocation proposed Caballeroniae a new sub family of this genus. Srivastava (1982) accepted genus Caballeroia, under sub family Caballeroiinae Yamaguti, 1971 and suppressed Caballeroinae Devraj, 1972 as Junior synonym. Under the genus Caballeroia he accepted two species, viz. C. indica Thapar, 1960 and C. bhavani (Achan, 1956) with the remark that the two species might be identical.

Genus *Caballeroia* Thapar, 1960 so far contains two species viz. *C. indica* Thapar, 1960, the type species collected from *Cirrhina fulangel* caught at Tungabhadra Dam, and *C. bhavani*

(Achan, 1956) Devraj, 1972 parasitic in the intestine of Barbus hexagonolepis and B. carnaticus from Bhavnisagar Reservoir. The latter species was orginally described as Nicolidiscus bhavani by Achan (1956) under the sub family Nicollodiscinae. Devraj (1972) this species and transferred it to the genus redescribed Caballeroia. Therefore, Caballeroia mihonai n.sp. is the third species to be added to this genus. The new species differs from C. indica and C. bhavani in having oesophageal bulb, shorter caeca terminating some distance anterior to acetabulum (vs caeca terminate in the region of acetabulum); 10 - 12 circular rows of papillae in the region of oral sucker and oral pouch (vs 5 rows in C. indica and 8 — 9 rows in C. bhavani); comparatively smaller acetabulum, 0.45 0 0.53 in diameter (vs 1.05 x 0.81 in C. bhavani and 1.0 in diameter in C. indica); limited distribution of vitellaria becoming contiguous in postovarian zone (vs in C. indica and C. bhavani extend from middle of caeca to its end not becoming contiguous posteriorly), presence of genital sucker and a pair of lyphatic canals.

Devraj (1972) described Y—shaped excretory bladder in *C. bhavani* but in my specimens as well as in *C. indica* it is saccular.

The new species is unique in possessing oesophageal bulb, prominent genital sucker and posteriorly contiguous vitelline

follicles. It is named *C. mihonai* n.sp. after the name of village Mihona from where the fish was collected.

Srivastava (1982) expressed doubt about the validity of *C. bhavani* as the differences shown by Devraj (1972) from *C. indica* were not much except the rows of papilae. Thapar (loc. cit) described *C. indica* on a single specimen. In view of the non—availability of type specimens of these two species it is difficult to decide their status. As such both are tentatively held valid. With the addition of *C. mihonai* n.sp. the sub family and generic diagnosis of Caballeroiinae and the genus *Caballeroia* required to be emended. It is interesting to note that the genus *Caballeroia* is confined to southern and northern part of the country in its distribution.

Paramphistomidae, body elongate, rounded posteriroly, covered with circular rows of small papillae. Acetabulum ventro—terminal, moderately large. Mouth subterminal, oral diverticles large claviform; oesophagous with or without oesophageal bulb, caeca reaching antero—lateral margin of acetabulum or not. Testes symmetrical or oblique, at times partly overlapping each other, intercaecal, reaching upto caeca laterally, smooth or crenulated, prequatorial. Cirrus pouch elongate, pymform or claviform,

contains convoluted vesicula seminalis and cylindrical cirrus, vesicula seminalis externa present. Genital pore bifurcat or just prebifurcat; genital sucker present or not. Ovary small, lateral or median, intercaecal near posteior end. Receptaculum seminis and Laurer's canal present. Vitellaria lateral, follicles restricted between ovarian and testicular zone along the caeca, at times contiguous in post—ovarian zone. Uterine coils intercaecal. Eggs oval or elongate. Excretory bladder saccular or Y—shaped (?), with antero—dorsal pore. Lymphatic ducts present or not. Parasitic in intestine of fresh water fishes.

Type genus : Caballei

Caballeroia Thapar, 1960

Generic diagnosis of Caballeroia: Same as for the subfamily.

KEY TO SPECIES OF THE GENUS CABALLEROIA

1. Rows of anterior papillae five; genital sucker; absent Rows of anterior papillae more than five; genital sucker present

C. indica

- 2
- Oesophageal bulb absent; vitellaria not contiguous in postovarian zone; caeca long

C. bhavani

3. Oesophageal bulb present; vitellaria contguous in postovarian zone; caeca short

C. mihonai n.sp.

The present specimen in my collection forms the new host and locality record from this region.

PART III LARVAL TREMATODES

Family : CLINOSTOMIDAE, Luhe, 1901

Sub Family: EUCLINOSTOMINAE Yamaguti, 1958

Genus: Euclinostomum Travassos, 1928

Metacercaria of *Euclinostomum heterostomum*(Rudolphi, 1809 Travassos, 1928) (Plate XXI, Fig. 1)

Metacercariae (Larval trematodes) of this species were collected in cysts from Body cavity of *Channa punctatus* (Bl.). Out of 360 specimens of *Channa punctatus* (Bl.) examined during 1995 to 1998, three fishes were found infected with these larval forms in the month of July and January. The fishes were procured from a pond at Bhind.

DESCRIPTION

Body large, oval, unspined with rounded extremities, measures $4.9-5.7 \times 2.42-3.03$ with collar like formation at anterior end. Oral sucker very small, oval, subterminal measures $0.3-0.44 \times 0.3-0.36$. Pharynx small, thick walled, measures $0.13-0.16 \times 0.16-0.18$, surrounded by loosely

arranged parenchymal muscles extending from posterior border of oral sucker to the base of collar, roughly halfway between intestinal bifurcation and acetabulum. Larval eye—spots present on either side of pharynx. Oesophagus absent. Intestinal caeca very thin upto posterior border of acetabulum, after which lateral diverticulae start. Lateral diverticulae are single and branched terminally postero—lateral, extending upto lateral margins of the body, their number being 11 on the left side and 12 on the right. Acetabulum very large, spherical, median, pre—equatorial, measuring 1.27 — 1.5 x 1.2 — 1.29 at a distance of 1.17 — 1.35 from anterior end.

Testes postequatorial, tandem, median, intercaecal. Anterior testis crescent shaped and posterior testis Y or V shaped, measuring $0.35-0.34 \times 0.77-0.79$ and $0.54-0.55 \times 0.54-0.58$ respectively. Vasa — efferentia of posterior testis runns parallel to right caeca and joins with vasa—efferentia of the anterior testis, then enters the cirrus sac as vas deferens. Cirrus sac small, oval, in front of anterior testis, in between its arms, enclosing bipartite seminal vesicle, pars prostatica and cirrus. Genital pore median, at the level of anterior third of cirrus sac.

Ovary small, oval submedian, intertesticular, intercaecal, measuring $0.12-0.17 \times 0.12-0.2$. Oviduct, short arising from

posterior border of ovary. Shellgland complex large, diagonally placed on one side of ovary. Metraterm very short and opens into genital atrium. Vitelline follicles very small, immature, lateral, extending from posterior margin of acetabulum upto posterior end of body and continuous in post—testicular region.

DISCUSSION

Travassos (1928) created the genus *Euclinostomum* with *Euclinostomum heterostomum* as its type species; a generic diagnosis was not given. Yamaguti (1958) created the sub—family *Euclinostominae* with *Euclinostomum* as its only genus.

The species *E. heterostomum* was first described as *Distoma heterostomum* by Rudolphi (1809). The description was rather brief and general dealing with external features and was without an illustration. Braun (1900) presented the first detailed account of the morphology of adult *E. heterostomum* from herons, *Ardea purpurea*. *A. cinerea* and *Nycticorax griseus*. Monning (1926) reported three metacercariae of *E. heterostomum* from the muscles of an unnamed fish. Joyeux and Houdemer (1928) recorded adult *E. heterostomum* from egrets, *Garzetta garzetta*. Metacercariae were found by them in the muscles of the fish, *Anabas scandens*.

Srivastava (1950) found metacercaria of E. heterostomum

from *Channa punctatus* embeded in the liver and attached to the kidneys or muscles of the coelomic wall. Adult worms occured naturally in the night heron, *Nycticorax nycticorax*.

Euclinostomum indicum was described by Bhalerao (1942) from the body cavity of Channa punctatus. Agrawal (1959) collected adult of *E. indicum* from herons, *Bubulcus ibis* fed with the fish Channa punctatus. Fischthal and Kuntz (1963) considered *E. indicum* Bhalerao, 1942 metacercaria; Agarwal, 1959, adult) synonym of *E. heterostomum*.

About a dozon species have been described so far under the genus *Euclinostomum*, of which five are from our country viz. *E. heterostomum*, *E. bhagvantami*, *E. Channai*, *E. hepatocaecum* and *E. indicum*. The characters utilized by previous workers for differentiating the known species of *Euclinostomum* are all highly variable and which include, the body shape, the structure of prepharynx, pharynx, oesophagus, number and shape of caecal diverticula. Perusal of literature shows that *E. heterostomum* the type species the genus, enjoys a wide host range and occurs in different geographical locality throughout the world. Its metacercariae are found in fresh water fishes consequently wide morphological variations in the anatomy are natural in this species.

The present specimens agree with the description given by the Braun (1900) except in the presence of well developed pharynx and vitellaria, which are considered as individual variations of *E. heterostomum*.

Host : Channa punctatus (Bl.)

Location : Body cavity

Locality: Bhind (M.P.)

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Family: ISOPARORCHIDAE

Genus: Isoparorchis Southwell, 1913

Metacercaria of *Isoparorchis hypselobagri*(Billet, 1898) *Odhner, 1927*(Plate XXII, Fig. 1)

Out of about seventy eight specimens of *Mystus vittatus* (Bloch) examined during the present, investigation during 1995—96, only six were found infected with metacereariae of a fluke which, on study, revealed to be the metacercariae of *Isoparorchis hypselobagri* (Billet, 1898) Odhner, 1927. The fishes were mostly obtained from the fish market at Morena but thirty seven specimens were collected with the help of fisherman from river Chambal. The latter were found infected with the metacercaria in question. Besides *Mystus vittatus*, other fishes viz., *Punitius ticto* (Hamilton), *Puntius sophore* (Hamilton), *Labeo calbasu* (Hamilton), *Rita rita* (Hamilton), *Xenentodon cancila* (Hamilton) and *Oxygaster bacaila* (Hamilton) were also examined for the metacercariae. One specimen of *Oxygaster bacaila* (Hamilton) obtained from the river Chambal at District Morena was found

harbouring only seven specimens of this metacercaria.

The metacercaria is described here in detail.

DESCRIPTION

<u>Habitat</u>: The metacercariae, varying from the one to five in number, were obtained from the body cavities of the hosts. They were found not encysted on visceral organs but in free state, and they appeared golden yellow or brown in colour. When taken out in the saline from the body cavities of its hosts, it showed active movements of expansions and contractions of its body. The preacetabular portion of body was extremely mobile.

Morphology: Body aspinose, thick and elongated, anterior end being more attenuated than posterior end. It measures 1.63 - 3.80 mm in length and 0.37 - 1.42 mm in maximum breadth at the equatorial region. Suckers well developed and circular in outline. Oral sucker subterminal and measures 0.09-0.36 mm x 0.12-0.31 mm. Ventral sucker much larger than oral sucker, pre—equatorial, situated at a distance of 0.21-1.24 mm. from the anterior and of body and measures 0.15-0.60 mm. x 0.16-0.63 mm. A preparynx is absent. Pharynx well developed and measures 0.04-0.15 mm. x 0.05-0.28 mm. Oesophagus extremely short but easily seen in live

specimens. It merasures 0.03 - 0.15 mm. in length. Intestial caeca broad and appear yellow or brown with the contained food matters. They run in a sinuous course upto posterior end of body. In the living condition, intestinal caeca have been observed undergoing at random contractions, and thereby ejecting the contents through mouth.

Gonads as yet, poorly developed. Testes appear as two small oval or round bodies located at the sides of ventral sucker in the intercaecal field. Right testis measures 0.01 - 0.07 mm x 0.01 - 0.09 mm. Left testis slightly larger than right testis and measures. 0.01 - 0.10 mm. 0.01 - 0.07 mm. Vasa efferentia arising from testes run forward and eventually unite, in front of ventral sucker, to form a short was deference which is continued into a narrow vesicula seminalis lying free in the body parenchyma. Vesicula seminalis is continued into a short ejaculatory duct enclosed in the so—called 'sinus sac' of Manter (1936). Genital pore median and located behind the intestinal bifurcation.

Ovary is present on the right side in the form of a transversly elongated structure in the hind region of body in front of the excretory bladder. A small pear shaped receptaculum seminis is present. A Laurer's canal is present. Vitellaria are in the incipient stage of development and are represented by dark staining cells

in front of the excretory bladder.

Southwell (1913) described the excretory vesicle as club shaped. His account, however, lacks details of the excretory system. Chauhan (1953), while giving the generic diagnosis of *Isoparorchis*, mentioned the excretory bladder to be Y—shaped. Yamaguti (1958) in the treatise 'Systema helminthum' appears to have followed Chauhan (1953) while giving the diagnostic feature of the genus *Isoparorchis* as he, too, states 'excretory bladder Y—shaped'. The author finds the excretory bladder to be a cylindrical structure in this fluke. The club shaped excretory bladder described by Southwell (1913) is attributable, in the opinion of the author, to the contraction of the body which usually happens during fixation.

DISCUSSION

The occurrence of the metacercariae of *Isoparorchis hypselobagri* has been recorded in India by Southwell and Prashad (1918), Bhalerao (1926, 1936), Chauhan (1947), Jaiswal (1957), Bhardwaj (1961), and Rai and Pande (1965) from various fresh water fishes viz. *Barbus tor, Ophiocephalus* Straiatus, *Notopteus notopterus, Ophiocephalus marulius, Ophiocephalus gachua, Mastacembalus armatus, Ambasis nana, Wallagonta attu' Gobius giuris, Clarias batrachus, Callichrous bimmaculatus,*

Belone cancila, Mystus seenghala, Mystus vittatus and Eutropiichthys vacha.

The adult fluke, I. hypselobagri, is common parasite of Wallago attu which being a predator, preys upon small varieties of fishes, the latter, when infected, possibly serve as transport hosts. Bhalerao (1932) reported immature forms of Isoparorchis sp. from a crocodile and Simha (1958) from a turtle in India. These reptiles do not appear to be the natural definitive hosts, most probably they contracted the infection accidentally by preying upon fishes infested with the metacercariae of Isoparorchis sp. Regarding the records of the occurrence of the metacvercariae of I.hypselobagri from foreign lands, Yamaguti (1934) reported his finding of the metacercariae of this fluke from several fishes in Japan. The present finding of the occurrence of the metaceracariae of I. hypselobagri on Mystus vittatus adds one more fish to the list of hosts recorded from India.

Host : Mystus vittatus (Bloch)

Location: Body cavity

Locality: River Chambal, District Morena.

It is a new host and locality record from this region.

• • • • • •

Family : BUCEPHALIDAE Poche, 1907

Sub family: BUCEPHALINAE Nicoll, 1914

Genus : Bucephalus Baer, 1827

Bucephalus chauhani n.sp. (Plate XXIII, Figs. 1—3)

During the present investigations, no adult fluke was recovered from fresh water fishes collected from river Chambal in District Morena. But two specimens of *Eutropiichthys vacha* out of a total of 107, and three of *Bagarius bagarius* out of 126, examined during a period of three years from July 1994 to June, 1997, yielded numerous encysted matacercaria from the mesentary and the body musculature. The intensity of infection varied from 13 to 58 metacercaria per host. Details of morphology including excretory system were traced from the study of living specimens and their stained mounts. With a view to study the invasive capability some of these cysts were fed to clean laboratory reared experimental rats and fishes. On detailed study of excretory system and other morpholoogical characters, metacercariae from both the hosts have been found identical and

to belong to a new species, *B. chauhani*, which is described below. The species is named in honour of Dr. P.P.S. Chauhan, Retired Professor of Parasirology, Veterinary College, Mathura (U.P.), an eminent helminthologist of India.

DESCRIPTION

Metacercaria

Encysted:— In living state, nearly rounded thin walled cysts have a whitish or cream colour and measure 0.98—1.2 mm in diameter. Characteristically folded excretory bladder is visible in the central portion of the cyst. The rhynchus and pharynx are well developed and lie at opposite ends.

In stained mounts the cysts measure 0.88 - 0.96 mm in diameter. The rhynchus measures $0.128 - 0.130 \times 0.186 - 0.192$ mm in size. Gastric sac nearly encircling the pharynx and the mouth measures 0.104 - 0.108 mm x 0.156 - 0.166 mm in size.

Excysted:— The actively motile and slippery flukes were released after the rupture of the cyst well. The various morphological details are: Body elongated with a broad anterior and slightly narrow posterior end, measures 1.92 — 2.02 mm in length and 0.72 — 108 mm in breadth; small cuticular spines are uniformly distributed on whole of the body; circular rhynchus lying anteriorly

in subterminal position measures 0.288 - 0.336 mm in diameter; A cluster of 7 - 11 apical glands lies on each side of the rhynchus; seven papilla like tentacular prominences lies just above the rhynchus on anterior end of the body; pharynx, lying a little posterior to body centre, measures 0.12-0.10 mm in diameter; gastric sac lies close to the pharynx.

In a freshly exysted fluke the tubular excretory bladder filled with dark matter and occupying most of the body space below the rhynchus to nearly the posterior end, opens through a sub—terminal excretory opening. The size of the excretory bladder gradually becomes smaller with the passage of time, allowing clear view of excretory details, when the worms are left free in physiological saline or fresh water for some time.

Excretory system:

The excretory system consists of a pair of small transverse excretory ducts originating at the level of the bladder. On each side these are joined by a lateral longitudinal duct running anteriorly to rhynchus and posteriorly reaching the body end. Each lateral duct gives off three ductules in anterior region and three in the posterior. Each ductule redivides into two final capillaries ending into a flame cell each. On the basis of this arrangement, the flame cell formula for these specimens, works

out to be 2(2+2+2) + (2+2+2).

DISCUSSION

The genus Bucephalus was created by Baer (1827) for B. polymorphus — a cercaria recovered from a European bivalve mollusc. Since then 58 species have been reported under this genus from marine and fresh water fishes from U.S.A., Canada, Japan, Korea, India, and many European countries. The first report on this genus, from fresh water fishes of India, was made by Verma (1936) who described two new species — B. tridenticularia from Macronius aoria and M. seenghala, and B. aoria from M. aoria. Subsequently Srivastava (1938) added two species namely B. indicus from M. seenghala and B. gangeticus Paeudotropius athernoides. Srivastava (1963), reported three more species viz. B. bagarious, B. tritentacularis and B. allahabadensis, all from Bagarius bagarius and synonymised B. indicus Srivastava, 1938 with *B. tridenticularia* Verma, 1936. Later on Kakaji (1969) described another species, B. octatentacularis from Wallago attu. Reviewing Indian Gastrostomes, Srivastava and Chauhan (1973) have analysed the systematic position of Indian species under the family Bucephalidae and have listed nine valid species under the genus Bucephalus.

As stated above, the fundation of this genus was laid down

on a cercarial species. But so far, only five cercarial/metacercarial species including B. polymorphus, have been reported from different parts of the world. India is represented by a lone report of Pande and Rai (1964) on a bucephalid metacercaria encysted in B. bagarius without any details of the excretory system. Stunkard (1975) has reviewed the systematic position of these metacercarial species and suggessted that all features, the exretory system with regard to the position of excretory ducts and their openings is the most reliable taxonomic character. In the light of these facts he has divided all metacercarial species of sub family Bucephalinae in two groups. In the first group the collecting ducts open into the proximal end of the excretory vesicle while in the second the collecting ducts open at the sides of the excretory vesicle. Out of a total of seven metacercarial species in group I, only one B. haemenus Lacaze and Duthiers, 1854 with the flame cell formula 2 (6+6+6) + (3+4+4+3): Matthews (1973), has been refeered under the genus *Bucephalus*. In group Il, out of a total of twelve, four species listed are B. polymorphus Baer, 1826; Zeigler (1983) (flame cell formula not known), B. cuculus MacCardy (1874) with 2 (2+2+2) + (2+2+2) : Hopkins (1954), B. elegans Woodhead, 1930 with 2 (7+7+7) + (8+8+9); Woodhead (1936) and B. cynoscion Hopkins, 1956 with 2 (2+2) + (2+2) : Hopkings (1956).

The present material on the basis of the presence of seven tentacular promineces, tubular excretory system and sub terminal excretory pore, can easily be assigned to the genus *Bucephalus*. On comparison with the known-metacercdarial species, the present from comes close to *B. cuculus* MacCardy, 1874 in having the similar material opening of collecting ducts on the sides of the excretory bladder as also the flame cell formula of 2 (2+2+2) + (2+2+2)*given by Hopkins (1956). But it differs from it in having a well developed transverse duct in a more posterior position and extent of lateral longitudinal ducts. Moreover, the size range of the metacercarial cyst and various organs also differ greatly in the excysted specimen.

In view of these differences the metacercariae are assigned to a new species, *Bucephalus chauhani* n.sp, named in honour or Dr. P.P.S. Chauhan, the retired Professor & Head of Deptt. of Parasitology at Veterinary College, Mathura.

EXPERIMENTAL INFECTION

Experimental infection with the metacercarial cyst of *B. chauhani* n.sp. was tried in the different hosts — a fresh water fish (*M. aor*) and a mammal (albino rat). The details have been tabulated as under. In both these hosts the infection proved abortive.

TABLE 1 — Experimental details of *B. chauhani* n.sp. infection in *Mystus aor* and Albino rats.

SI. No.	No.of cysts	Date of infection	Date of autopsy	Age of specimen	No. of specimens recovered
Mystus aor					
1.	15	15.4.95	22.4.95		
2.	15	15.4.95	29.4.95		
3.	° 15	15.4.95	6.5.95	-	
4.	15	15.4.95	13.5.95		
Albino rat					
1.	M 15	15.4.95	22.4.95	Additional	
2.	F 15	15.4.95	29.4.95	na/mateur	
3.	M 15	15.4.95	6.5.95		
4.	F 15	15.4.95	13.5.95		

NB — M — Male; F — Female

STRIGEID METACERCARIA

Diplostomulum majumdari n.sp. (Plate XXIV, Figs. 1 — 4)

Different developmental forms of a diplostomulum metacercaria were collected from the small intestine, body cavity, and body muscles of a fresh water fish, Silonia silondia (Hamilton). Thirteen specimen of this fish were available from the river Chambal in District Bhind (M.P.) during the year 1996—97. The intestine, on two occassions, yielded numerous immature forms and somewhat more developed specimens, on another occasion, were collected from the body cavity around the heart. The musculature, in two cases, revealed white cysts which, after extraction and subsequent teasing, yielded the fully developed forms. These different stages in the present collectioon were studie alive, subsequently suitably fixed, stained and mounted. Primary excretory system could not be traced. These specimens, on detailed study, were found belonging to a new species. It is designated as Diplostomulum majumdari n.sp. in honour of Prof.

G. Magumdar of University of Burdwan, Burdwan (West Bengal), an eminent helminthologist.

OBSERVATION

Specimens, collected from intestine and body cavity (Fig. 1), exhibited a finely striated body full of calcareous corpuscles and with a ventral concavity. Lateral sucking cups and smaller hind—body were only poorly differentiated. Acetabulum, slightly smaller than oral sucker, was located just behind the middle of the body. Genital rudiment and bursa copulatrix could be observed in hind—body with the hold—fast organ in the middle of the posterior half of the body. A pharynx and intestinal caeca were seen only in sections. Different measurements recorded are : length 0.4 — 0.52 mm, width 0.15 — 0.24 mm, oral sucker 0.028 — 0.032 x 0.032 — 0.036 mm, acetabulum 0.024 — 0.028 x 0.28 — 0.032 mm, hold fast organ 0.04 — 0.48 x 0.06 — 0.68 mm.

Cysts (Fig. 2), located mostly in the muscles of the trunk, were whitish in colour and in two parts — the outer fibrous part of host origin measured $1.2-1.56 \times 0.87-0.97$ mm, in size and the inner, full of fluid around the contained parsite, was $0.85-0.9 \times 0.35-0.44$ mm in dimensions. The juvenile stage exhibited two distinct but nearly equal regions — foliacious

fore body with oral sucker, lateral sucking cups, acetabulum and hold fast organ and hind body full of dark calcareous granules of 0.004 — 0.006 mm in size. On teasing the cyst, the parasite performed movements in normal saline and after 4—6 hours the internal anatomy, with essential details of its secondary excretory system, was evident under cover glass pressure (Fig. 3).

The specimens measured 1.19 — 1.28 mm in length and 0.51 - 0.58 mm in breadth, with the forebody of 0.61 - 0.66mm and the hind body 0.58 - 0.62 mm long. Sub terminal and almost circular oral sucker measured 0.08 x 0.81 mm in size. Lateral sucking cups were shallow in form and 0.06 x 0.12 mm in size. Pharynx measured 0.036 x 0.056 mm, directly dividing into intestinal caeca. Acetabulum, lying nearly at 1/4th of the body length from the anterior end, measured 0.052 x 0.1 mm in size. The nearly spherical hold fast organ, situated just behind the acetabulum and $0.12 \times 0.192 \text{ mm}$ in size, exhibited a prominent glandular area partcularly in its posterior region. Intestinal caeca were not visible on account of the darker contents of the excretory system and the calcareous granules. Secondary excretory system well developed with a large bladder located in the hind body and connected with a median and two lateral trunks extending anteriorly to near the pharyx and with three transverse commissures, one between the acetabulum and hold

fast organ, a second just behind intestinal bifurcation and the third anterior to it in the region of the lateral sucking cups (Fig. 3). The genital rudiments, in the hind body, are represented by four well defined masses, two on each side, consisting of a somewhat rounded anterior and an elongated posterior group — the former representing ovary and Mehlis' gland area and latter the two testes. Bursa copulatrix, at the posterior end of the hind body, received a tubular duct like structure. Spines, over the body, were absent.

DISCUSSION

Amongst the recognised strigeid larval genera, Diplostomulum Brandes, 1892; Neaseus Hughes, 1927, and Tetracotyle Fillipi, 1859 have been reported from some of our fresh water fishes. A Diplostomum larva was, for the first time, recorded from the fingerlings of Catla catla by Ganpati and Hanumantha Rao (1954). Subsequently, in 1955 they found metacercarial cysts in two other fishes, Labeo calbasu and Nuria danrica from fisheries pond. The other available reports on diplostomula are those of Abraham and Anantaraman (1955) who described black cysts, under the skin, in the fingerlings of C. catla and of Singh R.N. (1955) who gave an account of a new species, D. pigmentata, occurring in black pigmented cysts in muscles

of *C.catla, Cirrhina mirgala* and *Labeo rohita.* These reports are either based on high mortalities or heavy infestations encountered. Singh, K.S. (1957), evidently not aware of these papers, described another new species, *D. elongatus*, collected from transparent cysts found loosely attached to the mesentery in *Trichogaster fasciatus*. Recently Ganpati and Hanumantha Rao (1962), extending their earlier observations to some of the life history stages including metacercaria to adult, have identified the young stages as belonging to *Diplostomum ketupanensis* Vidyarthi, 1937. Referring to the form described by Abraham and Anantaraman as identical to the one described by them, these authors have also mentioned that *D. pigmentata* Singh, 1956 was also similar to it.

The present material on account of its aspinose cuticle, non pigmented character of its cysts, nearly equal size of the fore—and hind—body and absence of an oesophagus appears distinct from the metacercarial forms studied by Ganpati and Hanumantha Rao, Abraham and Anantaraman, and Singh R.N. This form, from the body cavity around heart of *Silonia silondia* (Hamilton) is, therefore, assigned tentatively to a new species of *Diplostomulum*, *D. majumdari* n.sp. It can easily be distinguished from *D. elongatus* Singh, 1957 which, inside transparent cysts, occurs loosely attached to the mesentery, is much smaller in size

and lacks entirely the calcareous granules. The forms, recovered from intestine and body cavity, were distinctly younger in development and apparently represented the stage prior to its entry into the musculature where the characteristic metacercarial cysts subsequently develop. Question of validity of the various diplostomulae and the allied larval forms in strigeids can best be settled after work on the life cycle studies has been conducted and the adult forms, developing from them, are avalable for comparison.

Host : Silonia silondia (Hamilton)

Location: Small intestine, Body cavity,

Body muscles.

Locality: Chambal river, District Bhind (M.P.).

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(164)

Family : STRIGEIDAE Railliet, 1919

Sub family: STRIGEINAE Railliet, 1919.

Prohemistomulum jaini n.sp. (Plate XXV, Figs 1—3)

Out of 23 fresh water fishes, belonging to species *Badis* badis (Hamilton), catched from river Chambal in District Morena (M.P.), only one fish was found infected with a metacercarial cyst. The cysts were attached with the body muscles. On detailed examination it appeared to be a strigeid belonging to larval genus *Prohemistomulum* Ciurea, 1933. It is designated as *Prohemistomulum jaini* n.sp. in honour of Dr. S.P. Jain, D.Sc. of Agra College, Agra, a prominent helmintholist and is described herewith.

Cyst (Fig. 1) is rounded, double layered, thin, and measures $0.40-0.50~\mathrm{mm}$ in diameter. It breaks easily under the pressure of coverslip.

Body (Fig. 2) is oval, spinose, with rounded ends, measuring $0.26-0.30 \times 0.12-0.15$ mm. Oral sucker is terminal

and measures $0.06-0.08 \times 0.06-0.07$ mm. Ventral sucker is circular, smaller than oral sucker, located behind the middle of the body and measures 0.01-0.02 mm in diameter. Hold fast organ is almost circular in outline and measures $0.08-0.09 \times 0.05-0.06$ mm. Hold fast gland is present at the postero lateral margin of the hold fast organ. Prepharynx is indistint. Pharynx is wide, elongated and measures $0.03-0.04 \times 0.04-0.05$ mm. It leads into 0.03-0.04 mm long, tubular, oesophagus. Intestinal caeca are symmetrical, terminating in the hind body region. Gonads are well developed and represented by three dark stained masses of cells, linearly arranged along with the lateral margins of hold fast organ. Anterior mass represents the ovary while the other two masses represent the testes.

Excretory bladder (Fig. 3) is 'V' shaped and opens out terminally through an excretory pore. The excretory system consists of two main collecting canals one one each side of the body. They unite anteriorly by a transverse canal. A short median canal arises from the transverse canal and divides into two lateral canals which open into the main canals in the acetabular region. The whole arrangement of canals appears as W—shaped. A number of small, round excretory corpuscles move freely inside the excretory canals.

Since the present metaceraria has (1)—Body round to oval, flat, not separated into two parts, (2)-No lateral pseudo-suckers and (3) — A reserve excretory system consisting of three main vessels united to form 'W' shaped pattern containing free moving excretory corpuscles, it is, therefore, placed under the larval Prohemistomulum Ciurea, 1933. It shows strigeid group resemblence with the following metacercariae viz, Metacercaria of C. orientalis Faust, 1922; Prohemistomulum circulare Ciurea. 1933; C. melanittae Yamaguti, 1934; Metacercvaria of C. nravieri Mathias, 1935; Metacercaria of Prohemistomulum chandleri Vernberg, 1952; Metacercaria of C. bushiensis Khan, 1962; Prohemistomulum metacercaria Rai and Pande, 1969 and Metacercaria of C. bithyniae Sudarikov, 1964. The present larva chiefly differs from all the above species in the shape and arrangement of genital rudiments.

Host : Badis badis (Hamilton)

Location: Body muscles

Locality: River Chambal, District Morena (M.P.)

EXPLANATION OF PLATES & FIGURES AND PLATES I TO XXV

EXPLANATION OF PLATES AND FIGURES

PLATE I

Fig. 1. Allocreadium handiai Pande, 1937 (Ventral View)

PLATE II

- Fig. 1. Bucephalopsis nekpuri n.sp. (entire). Ventral View.
- Fig. 2. Bucephalopsis hardayali n.sp. (entire). Vental View

PLATE III Bucephalopsis gaurai Verma, 1936

- Fig. 1-3 Adult mature worm (Ventral view).
- Fig. 4 Showing the pharynx between two testes.
- Fig. 5 Showing the vitelline follicles in anterior part of body.
- Fig. 6 Showing the ovary anterior to intestine.

PLATE IV Bucephalus kailarasi n.sp.

- Fig. 1. Adult mature worm (entire), Ventral view.
- Fig. 2. Rhychus with four tentacles at oral end.

PLATE V Neobucephalopsis dholpurensis n.sp.

Fig. 1. Adult mature worm (entire). Ventral view.

PLATE VI Gorgotrema barbius Dayal, 1938

- Fig. 1. Adult mature worm (entire). Ventral View.
- Fig. 2. Ovary and ootype complex (enlarged).
- Fig. 3. Vesicula seminalis and metraterm (enlarged).

PLATE VII Phyllodistomum chandrai n.sp.

Fig. 1. Adult mature worm (entire) Ventral view.

PLATE VIII Phyllodistomum agarwali n.sp.

Fig. 1. Adult mature worm (entire) Ventral view.

PLATE IX Phyllodistomum tripathi Motwani and Srivastava, 1961

- Fig. 1. Adult mature worm (entire). Ventral view.
- Fig. 2,3. Showing different positions of testes.
- Fig. 4 Showing different course of intestinal caeca.

PLATE X Genarchopsis dwivedii n.sp.

- Fig. 1. Adult mature worm (entire) Ventral view.
- Fig. 2. Showing two large compact or lobed masses of vitellaria lying very closely in the posterior region of body. (Dorsal view).
- Fig. 3. Showing two vitellaria masses forming a symmetry with two testes and an ovary (Dorsal view).
- Fig. 4. Showing two testes smaller than the ovary (Dorsal view).
- Fig. 5. Eggs with filaments.

PLATE XI Genarchopsis piscicola Srivastava, 1933.

Fig. 1. Adult mature worm, Ventral view.

PLATE XII Genarchopsis singularis Srivastava, 1933

Fig. 1. Adult mature worm, Ventral view.

PLATE XIII Genorchopsis goppo (Tubangui) Ozaki, 1925

Fig. 1. Adult mature worm, Ventral view.

PLATE XIV Haplorchoides seenghali Dayal and Gupta, 1954.

Fig. 1. Adult mature worm. Ventral view.

PLATE XV Haplorchinae flukes

- Fig. 1-3. Showing the spindle shaped worms, *Haplorchis attenuatus* Srivastava, 1935.
- Fig. 4. Showing the acetabulum in *H. attenuatus* with circlet of 42-48 fret-saw-shaped rodlets (in single row).
- Fig. 5. Showing the acetabulum in *H. piscicola* with weak chitinised 35-40 fret-saw-shaped rodlets.

- Fig. 6. Showing in *H. attenuatus* the seminal vesicle through a small ejaculatory duct, terminally opened jointly with metraterm into the ventro-genital complex.
- Fig. 7. Showing in *H. piscicola*, the ascending uterine limb continued into distinct metraterm which opens terminally alongwith the ejaculatory duct into the posterior border of the genital sinus (genital atrium).
- Fig. 8. The operculated and fully embryonated egg of *H. attenuatus*
- Fig. 9 The operculated and fully embryonated eggs *H. piscicola.*

PLATE XVI Haplorchinae flukes

- Fig. 10-13. The mature worms, *Haplorchis piscicola* Srivastava, 1935 of different shapes and sizes.
- Fig. 14 The mature worm, *H. attenuatus*, showing the termial excretory pore opening into the sac-shaped excretory bladder.

PLATE XVII Asymphylodora chambali n. sp.

Fig. 1. Adult mature worm (entire), Ventral view.

<u>PLATE XVIII</u> Neopodocotyle dholpuri n.sp.

- Fig. 1. Mature worm (entire), Ventral view.
- Fig. 2. Oesophagus and cirrus pouch (enlarged)
- Fig. 3. Cirrus pouch (enlarged).

PLATE XIX Neopodocotyle morenai n.sp.

Fig. 1. Adult mature worm, Ventral view.

PLATE XX Caballeroia miohonai n.sp.

Fig. 1. Adult mature worm. Ventral view.

PLATE XXI Metacercaria of Euclinostomum heterostomum (Rudolphi, 1809) Travassos, 1928.

Fig. 1 Excysted Cyst.

PLATE XXII

Fig. 1. Metacercaria of *Isoparorchis hypselobagri* (Billet, 1828) Odhrier, 1927.

PLATE XXIII Bucephalus chauhani n.sp.

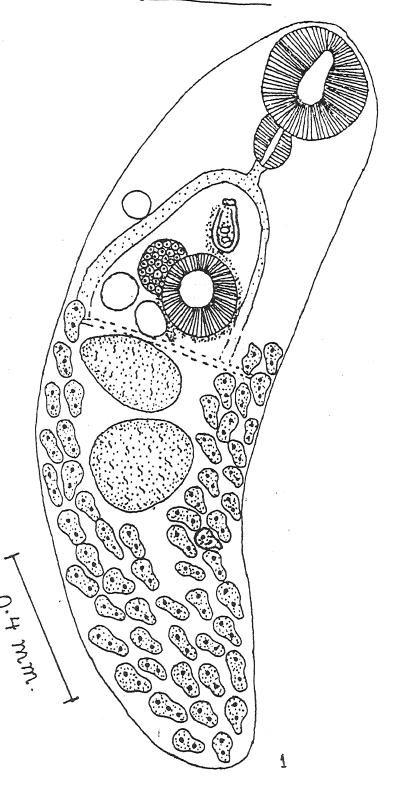
- Fig. 1. Metacercarial.cyst in living state.
- Fig. 2. Freshly excysted cyst.
- Fig. 3. Excysted larva after three hours showing the excretory system. (The excretory ducts and flame cells are shownmuch enlarged and not proportionate to the scale given for this figure).

<u>PLATE XXIV</u> Diplostomulum majumdari n.sp.

- Fig. 1. Developing diplostomulum. Entire mount showing two suckers, hold-fast organ, genital rudiment and region of bursa-copulatrix.
- Fig. 2. Metacercarial cyst showing the outer and inner walls with the harboured stage.
- Fig. 3. A metacercaria removed from the cyst and showing oral sucker, pharynx, intestinal caeca, lateral sucking cups, acetabulum, hold-fast organ and secondary excretory system.
- Fig. 4. Permanent stained mount showing oral sucker, pharynx intestinal bifurcation, acetabulum, hold-fast organ, lateral sucking cups in the fore-body and genital rudiments with bursa copulatrix in the hind body.

<u>PLAGE XXV</u> Prohemistomulum jaini n.sp.

- Fig. 1. Metacercarial cyst.
- Fig. 2. Excysted metacercaria
- Fig. 3. Excretory sytem in the metacercaria.



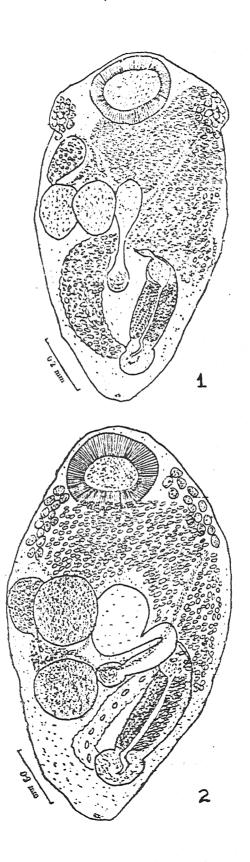


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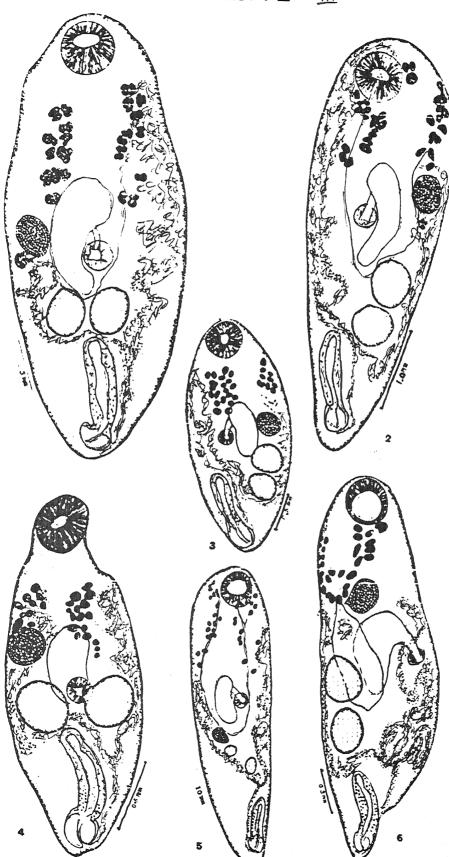


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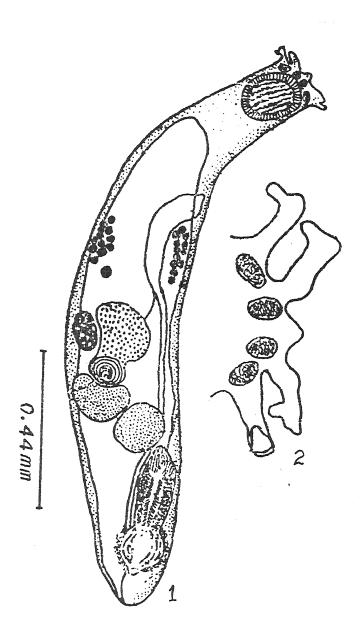


PLATE Y

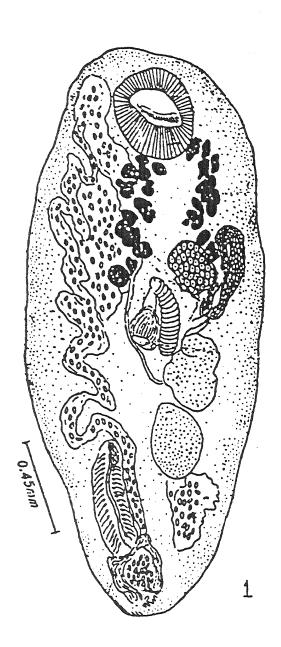
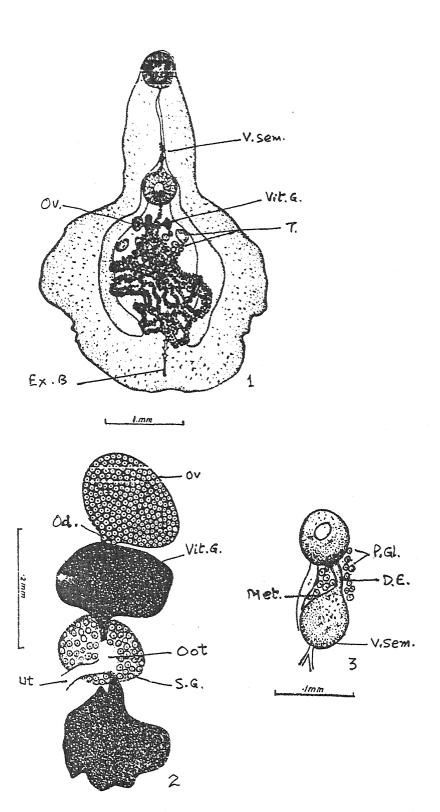


PLATE VI



Ex.B. Excretory bladder; Met. Metraterm; Od. Oviduct; Oot. Ootype; Ov. Ovary; P.Gl. Prostate Glands; S.G. Shell Glands; T. Testes; Ut. Uterus; Vit.G. Vitelline Glands; V. Sem- Vesicula Comité l'incomme

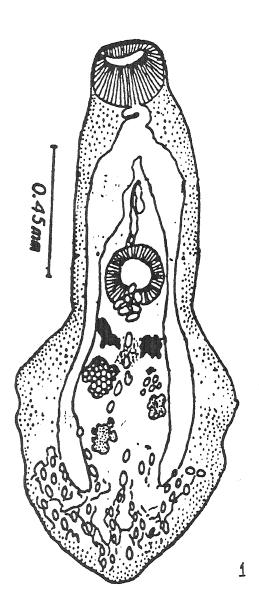
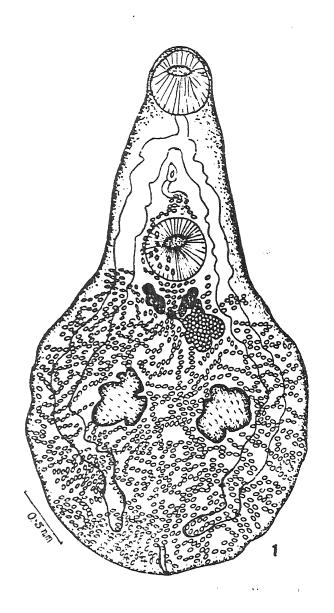


PLATE VIII



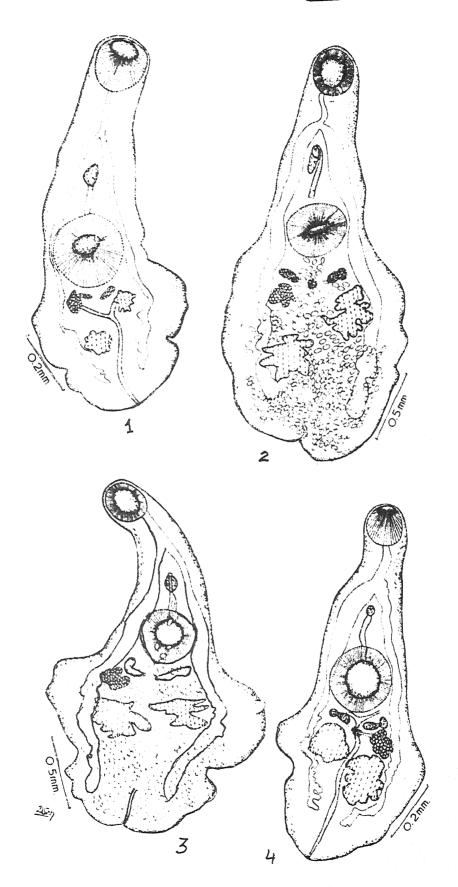
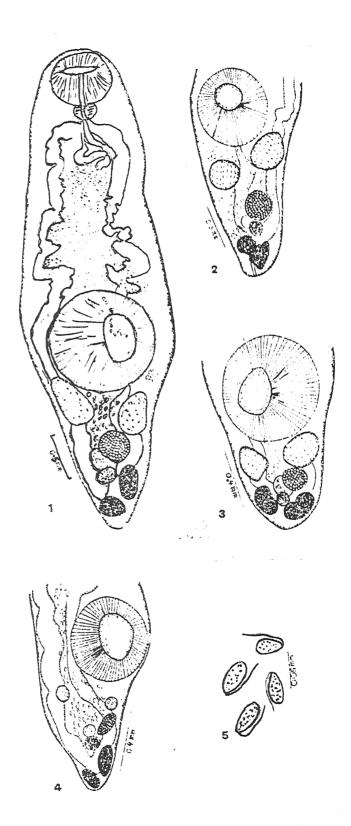
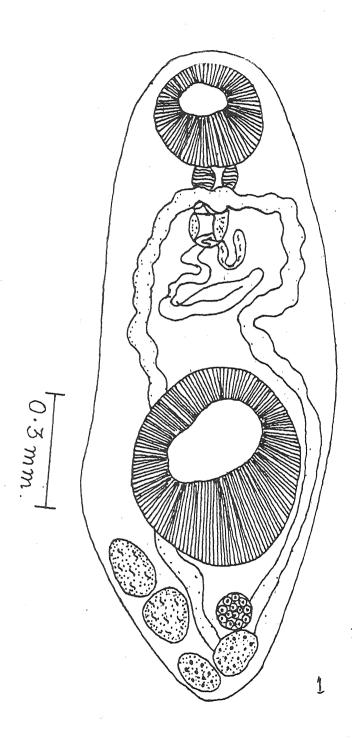
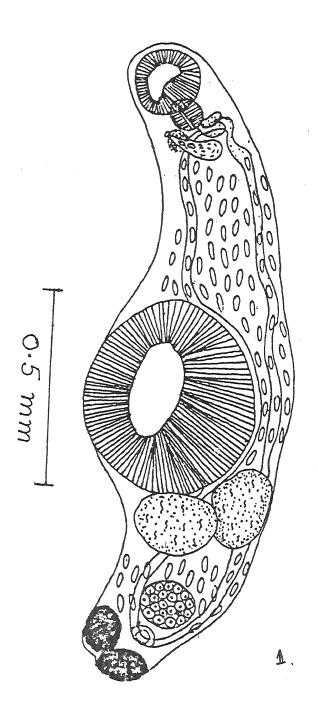
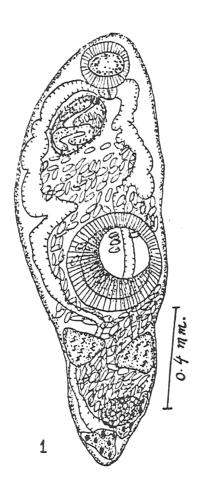


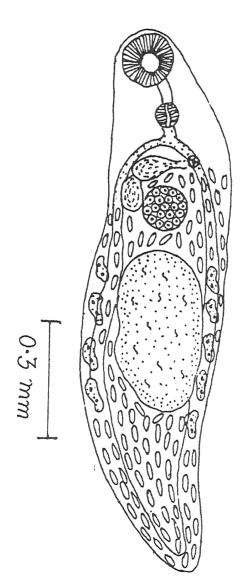
PLATE X





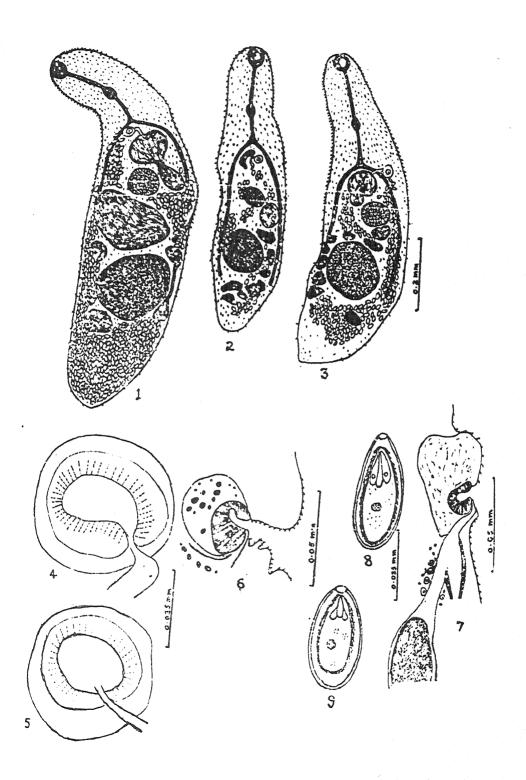


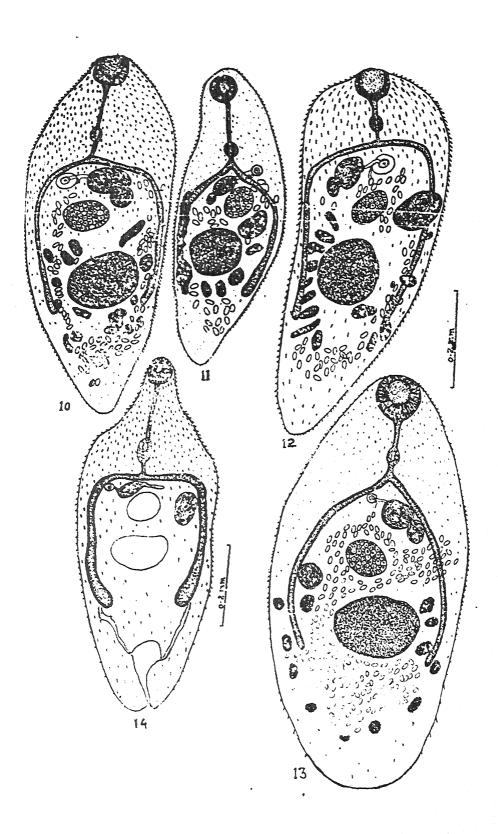




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PLATE XV





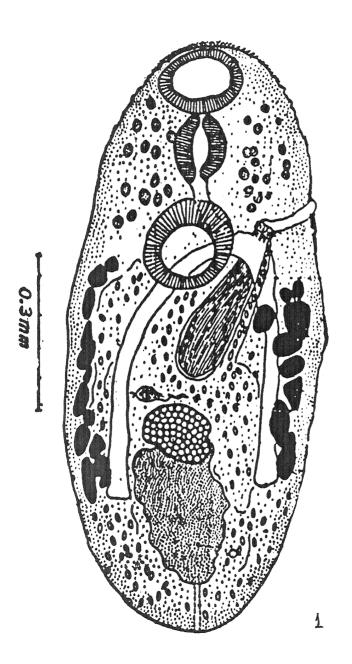


PLATE XVIII

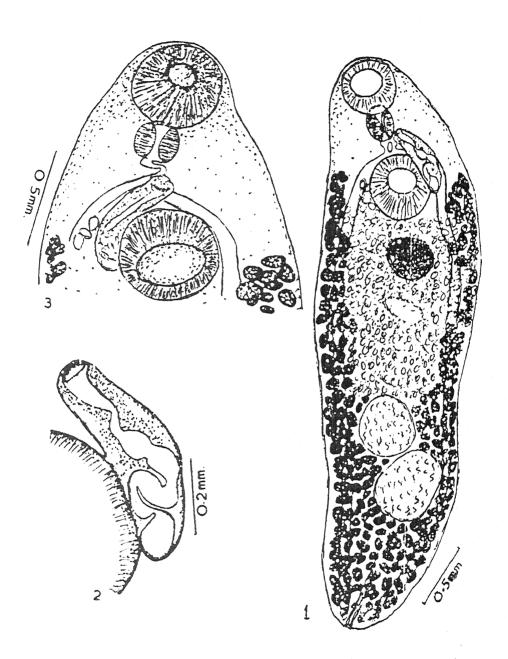
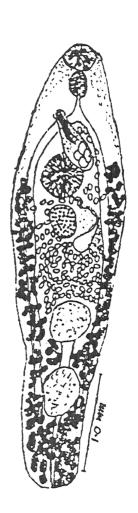


PLATE XIX



And

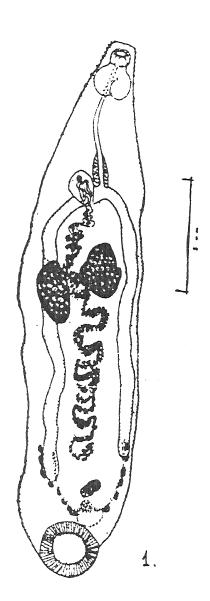
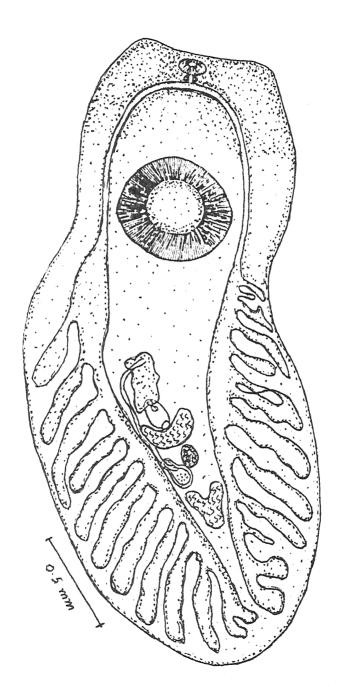
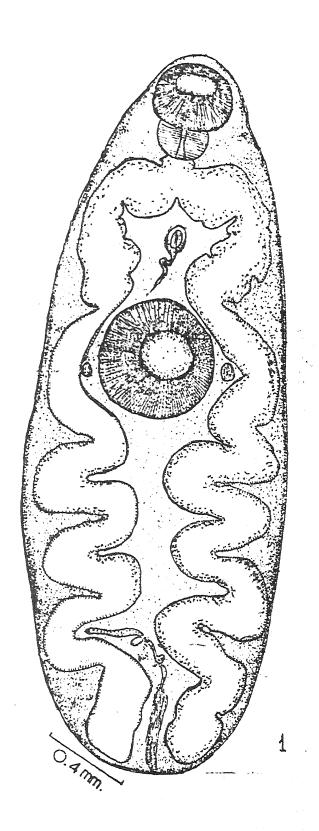
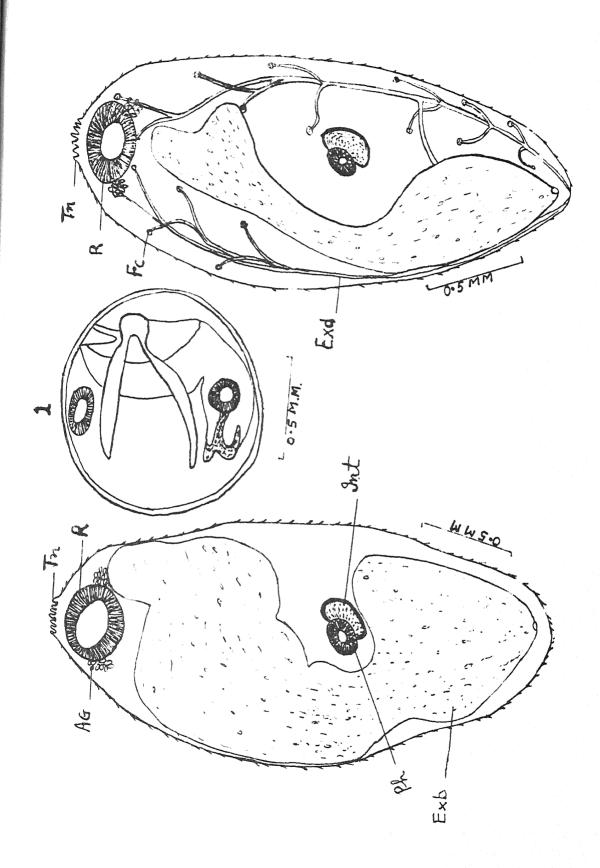


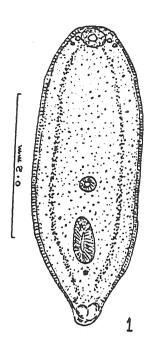
PLATE XXI

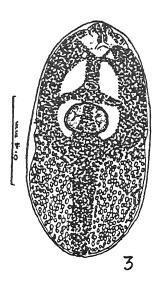


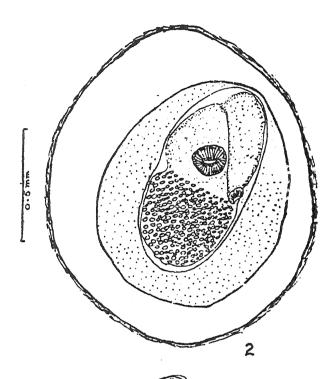
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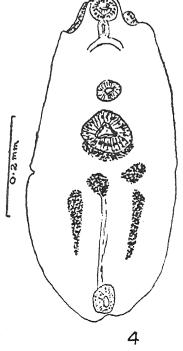
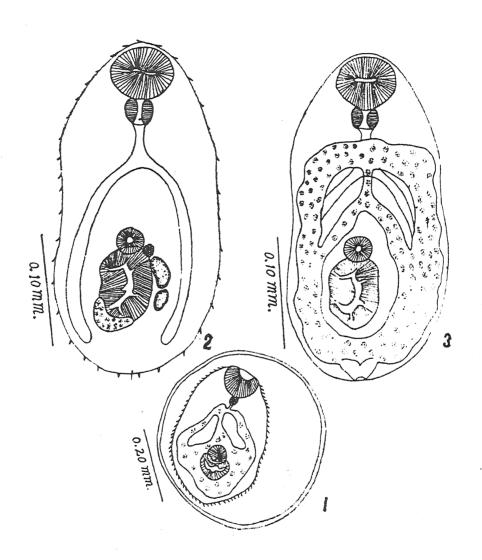


PLATE XXV



SUMMARY

Due to complelling economic reasons the fish farming is developing fast into a major profitable industry. In India over 7.5 million people depend on fish and fishery for their livelihood, while 23,000 are engaged in ancillary vocations such as basket and ice making, fish processing and transport etc. The fish fauna, constituting one of most economic groups provides proteins, many medicinal and industrial Oils, vitamins, insulin, enzymes etc.

Fish like other animals are prone to a number of diseases which are responsible for heavy losses due to mortality and morbidity. The helminthic parasites cause various parasitic dfiseases in fishes. The trematode parasites are mainly responsible for such diseases in the fishes. Fish born zoonsis is more significant specially in case of trematode parasites.

With this background in mind, the present study was undertaken. The observations embodied in the thesis ared based on the study of material gathered from extensive survey of digenetic terematode parasites only from Chambal river passing through the Chambal region, and other water bodies of the area.

This study has brought certain facts to our knowledge, such as the fish a fauna usually found in water bodies and the only

river of Chambal region, the digenetic trematode parasite which are found in them, and the intensity of infection in these fish hosts.

The fishes were collected regularly from water bodies, the river and ponds etc. and from the local markets in the cities where supply of fishes is generally from these ponds and river for a period of three years, from July 1994 to June, 1997.

A total of about 1965 fishes were examined from these water sources of the Chambal region. A thorough search was done to collect the parasites from various organs of the fishes.

Soon after collection the trematodes were studied alive to observe spines or papillae if any, excretory system and genital opening. For preparing whole mount of trematodes the worms were relaxed in fresh water for some time. The body was gently stretched by adding luke warm water. Specimens were kept in 5 — 10% formaline overnight to fix, then washed with water. The worms were dehydrated by passing in the series of alcohol, stained in borax carmine or acetic alum carmine, cleared in xylene or clove oil, and finally mounted in DPX or Canada balsum.

The diagrams were prepared with the help of a camera lucida in a proper magnification.

The work incorporated in the present thesis is divided into three parts.

Part I deals with the Introduction, Historical Resume, Material and Methods, A systematic list of hosts collected and examined from Chambal river and other water bodies, and a Parasite—Host list.

Part II deals with the taxonomical and morphological studies on 19 selected trematode parasites (excluding five metacercarial forms described in Part III) recovered during the study period. Their descriptions are grouped taxonomically. Mention has not been made of nematode and cestode parasites as these were not the part of the project. Out of 19 trematode species described, eleven have neen described as new species whereas the eight are redescribed in detail, furnishing further information and observations which were essential to enrich our existing knowledge on these parasites. They are known forms but majourity of these form the first host and locality record from this region. In case of trematodes from Indian fishes belonging to sub family Haplorchiinae under family Heterophyidae, their validity has been discussed in detail and only two species are considered valied.

These trematode parasites belong to 11 genera and 8

families of the order Digenea.

The trematodes included in this part are:-

- 1. Allocreadium handiai Pande, 1937 has been recorded from the intestine of four host species, i.e. Clarias batrachus (Linn.); Heteroprieustes fossilis (Bl.); Channa punctatus and Channa striatus (Bl.) by the shape of the body, acetabulum smaller than oral sucker, tandem testes and small ovary attached to acetabulum.
- 2. Two new species of the genus *Bucephalopsis* (Diesing, 1855)

 Nicoll, 1914 namely *B. nekpuri* and *B. hardayali* have been described. Both the species have been collected from the stamach of *Xenontodon cancila* (Hamilton). *B. nekpuri* n.sp. is characterised by having a collar like constriction, position of gonads in prepharyngeal zone on same side, parallel testes on same side of intestinal and parallel with intestine. *B. hardayali* n.sp. is differentiated from other species of the genus in the position of ovary being lateral to anterior testis and in line with intestinal sac, in position of ootype being immediately anterior to posterior testes.
- 3. A redescription of *Bucephalopsis gaurai* Verma, 1936 is given. The species was collected from the intestine of *Pseudeutropicus garua* (Hamilton). It has been observed that

there is great variability in the position of internal organs and considerable variations in the dimensions of the organs. All these characters are considered the intra specific variations. It forms the first host and locality record from this region.

- 4. Bucephalus kailarasi n.sp. has been described. It was collected from the small intestine of Corica soborna (Hamilton). The new form has an entirely different disposition of testes and structure of the tentacles.
- from the small intestine of *Clupiosoma garua*. The fish host was procured from Chambal river in the district Dholpur (Rajasthan). The new specis bears a distinct identity in having aspinose skin; ratio between body length and breadth and ratio between anterior and posterior testis; sacculated intestine with a characteristic annulated appearance relatively more cephalad position of the ovary and short size of cirrus sac etc.
- 6. Gorgotrema barbius Dayal, 1938 has been redescribed. The species was collected from the kidney of Barbius bola (Hamilton). The distinguished characters of the species are (1) body flat, divided into an anterior elongated neck—

like portion and a posterior broad circular portion, (2) long oesophagus, broad intestinal caeca, (3) tubular excretory bladder with lateral branches, (4) genital opening anterior to intestinal bifurcation, (5) testes follicular, in large numbers, scattered in anterior half of body, and (6) uterine coil mostly intercaecal.

- 7. Phyllidistomum chandrai n.sp. has been collected from the urinary bladder of Gudusia chapra (Hamilton). The fish host was procured from Chambal river in the district Morena (M.P.). The new species differs from other species of the genus by possessing a new host record, ratio between body length: breadth and between oral sucker: acetabulum, position and size of ovary and in having biparite vesicula seminalis.
- 8. Another new species *Phylodistomum agarwali* has also been collected from the urinary bladder of *Rita rita* (Hamilton). It is the new host record for the genus. The new species is characterised in having suckers of equal size, in having posterior body part disc like separated from much narrower anterior portion and in having ovary anterior to testes.
- 9. A redescription of *Phylodistomum tripathi* Motwani and Srivastava, 1961 is given. The variations met within the

- species are discussed. It forms the first host and locality record from this region.
- 10. *Genorchopsis dwivedii* n.sp. has been collected from the stomach of *Channa punctatus* (Bloch) and described. The new species differs from all the known species of the genus in the possession of a well developed receptaculum seminis and in having genital pore close behind the pharynx.
- 11. *Genarchopsis piscicola* Srivastava, 1933 has been recorded from the intestine of *Channa punctatus* (Bl.). It characterised by small and fusiform body. Oral sucker cuplike, acetabulum large and well developed, prepharynx and oesophagus absent. Cirrus sac absent, uterine coils intercaecal, extending posteriorly upto the hind border of the testes. This recorded form has been described from Chambal region.
- 12. *Genarchopsis singularis* Srivastava 1933 has been collected from the intestine of *Channa punctatus* (Bl.). It is characterised by small oesophagus, symmetrical testes, cirrus sac absent and two compact vitellaria.

The parasite forms the first host and locality record.

13. Genarchopsis goppo is redescribed. The various variations

met within the worms and validity of various species have been discussed. A detailed perusal of litrature shows the characters used by earlier workers. In the light of this study, an attampt has been made to re—study various species of the genus for their validity.

14. Haplorchoides seenghali Dayal and Gupta, 1954 has been recorded from the intestine of *H. fossilis* (Bl.). It is characterised by small size of body, lage size of testis, absence of cirrus pouch and acetabulum.

It forms the first host and locality record.

15. From a study of numerous specimens of worms belonging to sub family Haplorchiinae under the family Heterophiydae studies from five species of Indian siluroid fishes, the twelve species have been described so far under *Haplorchis, Monorchotrema, Pseudohaplorchis* and *Haplorchoides*. The only criterion of taxonomic importance in addition to the body shape is the armature of rodlets carried by acetabulum embedded in the ventrogenital complex. In the present study the validity of certain characters met within the various species belonging to different genera have been discussed. Accordingly, only three species of the genus *Haplorchoides* viz. *H. attenuatus, H. seenghali* and *H. piscicola,* are

- considered the valid while the remaining species are synonymised with these three species.
- 16. Asymphylodora chambali n.sp. is collected from the intestine of *Puntius sarana* (Hamilton). The new species is characterised by the ratio of body lenght and breadth, the posterior extent of intestinal caeca reaching upto middle of testis, the position of ovary and vitellaria, and the seminal vesicle not bipartite.
- 17. A new species, *Neopodocotyle dholpuri* has been collected from the intestine of *Ambasis nama* (Hamilton) procured from Chambal river in the district Dholpur. It is characterised and differentiated from the other species of the genus by the presence of pars prostatica and the extension of cirrus pouch upto middle part of the ventral sucker.
- 18. Another new species of the genus *Neopodocotyle* Dayal, 1950 is *N.morenai* which has been collected from the intestine of *Rita rita* (Hamilton), which was procured from Chambal river in the district Morena. It is characterised by having two testes situated apart from another at a distance and possessing a cirrus pouch (sac) which extends anteriorly, crosses the anterior part of right intestinal caeca.
- 19. A new species of an amphistomatous parasite, Caballeroia

mihonai is described. It was collected from the intestine of Macrognathus aculeatus (Bloch.). The species is described alongwith a review of the status of the genus and its existing species. The new species is unique in possessing an oesophageal bulb, prominent genital sucker and posteriorly contiguous vitelline follicles.

The present specimen forms the new host and locality record from this region.

Part III deals with the description of five metacercarial forms recovered from the different fishes in cyst form. It includes

1. Metacercaria of *Euclinostomum heterostomum* (Rudolphi, 1809) Travassos, 1928 has been collected from the body cavity of *Channa punctatus* (Bl.). It is characterised by presence of well developed pharynx and vitellaria, body large with collar like formation at anterior end. Intestinal caeca very thin upto posterior border of acetabulum with lateral diverticulae. Vitelline follicles very small and immature.

This recorded form has been described from this region.

2. The metacercaria of *Isoparorchis hypselobagri* (Billet, 1898) Odhner, 1927, has been recorded from the body cavity of

Mystus vittatus (Bloch). It is described. This metacercaria has been reported from various fish species in India and Japan. It is characterised by the presence of thick cuticle on body, intestinal caeca long and serpentine, and acetabulum large than oral sucker. It forms a new host and locality record from this region.

- 3 Bucephalus chauhari n.sp. is described. The metacercariae of this new species were recoverd from two specimens Eutropiichthys vacha (Hamilton). A brief review of various reports on the genus Bucephalus is made. Detailed morphological description with special reference to excretory system of the species is given. Additionally, experimental infection to piscine and mammalian hosts is also attempted to assess the invasive capability of the new species.
- 4. A strigeid metaccrcaria, *Diplostomulum majumdari* n.sp. is described. It has been collected from the body cavity, around the heart of *Silonia silondia* (Hamilton). Its chief characteristics are the presence of aspinose cuticle, non pigmented character of its cysts, nearly equal size of the fore and hind body and absence of an oesophagus.
- 5. Prohemistomulum jaini n.sp., another strigeled metacercaria found attached with the body muscles of Badis badis

(Hamilton), is described. This larva differs from all known larvae of group *Prohemistomulum* Ciurea, 1933 on account of its shape and arrangement of genital rudiments.

In the end a list giving the explanations of 25 plates including 61 figures is given. Twenty five plates containing 61 figures are added. Further, a brief 'Summary' of the work done and included in the thesis is also given in the end. The selected References of the literature cited are also given.

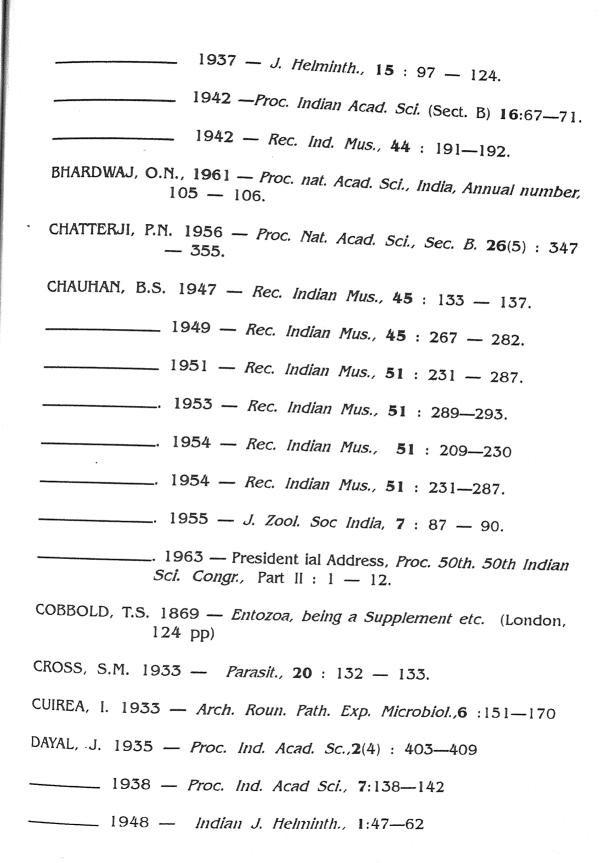
The present thesis extends over pages and is illustrated with twenty five plates containing 61 camera lucida diagrams of the twenty four trematode species described including five larval trematodes (metacercarial forms).

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